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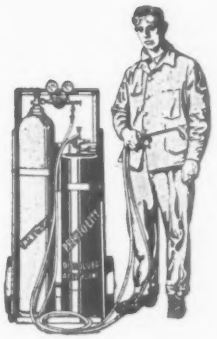
A. S. Burleson, Postmaster General.

The Welding Engineer

Vol. III. Chicago 608 S. Dearborn St. JANUARY, 1918 $2.00 per year in U. S. $2.50 per year abroad No. 1

Prest-O-Lite Acetylene Service



Behind Prest-O-Lite Acetylene Service stands the world's largest acetylene organization.

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Canadian General Office and Factory, Dept. B-7, Toronto, Ontario
59 Branches and Charging Plants in Principal Industrial Centers

World's Largest Makers of Dissolved Acetylene

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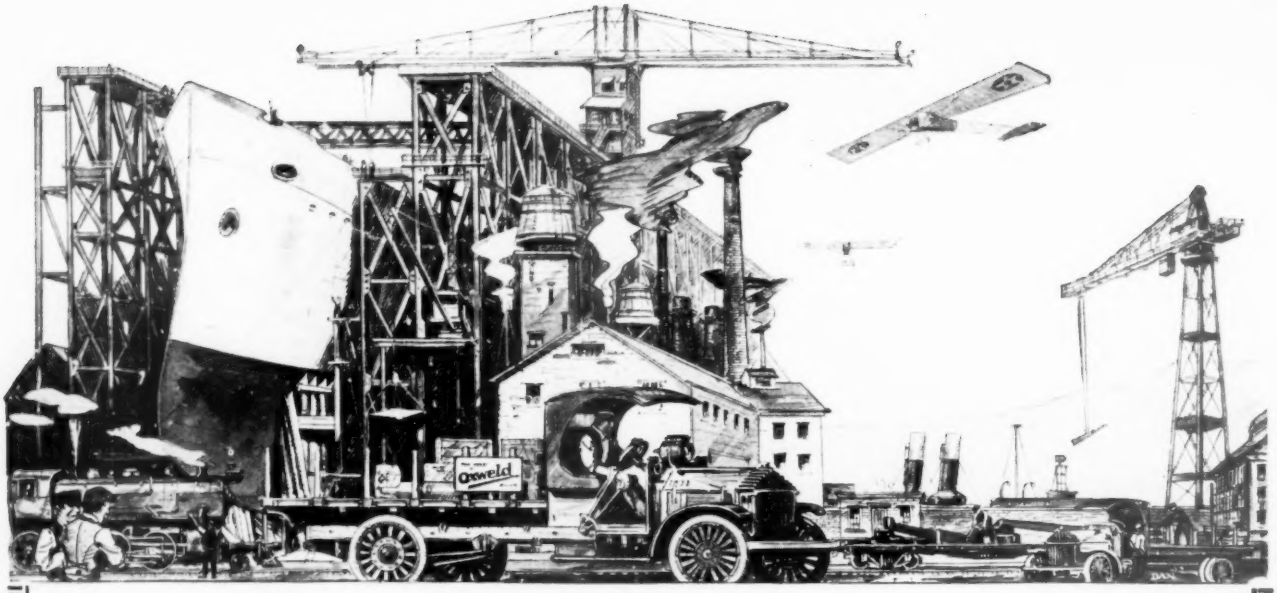

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Equipment and Service

is playing a mighty part in all this great program. Readers of this journal will find the data and figures well worth studying and we will be pleased to send them on request.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Commercial Acetylene Welding Co.
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Universal Oxygen Co.

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Universal Oxygen Co.

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Morey Flux & Chemical Co.
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Torchweld Equipment Co.
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Universal Oxygen Co.

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Burdett Oxygen Co.

ASBESTOS SHEET PAPER
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Burdett Oxygen Co.
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The Alexander Milburn Co.
The Prest-O-Lite Co.
Torchweld Equipment Co.

BOOKS (Relating to Welding)
The Welding Engineer
P. F. Willis.

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Hauck Mfg. Co.
Bermo Supply Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
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Superior Oxy-Acetylene Machine Co.
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Bermo Supply Co.
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The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

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Union Carbide Sales Co.

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CARBO-HYDROGEN
Carbo-Hydrogen Co. of America

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Messer Mfg. Co.
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Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Mach. Co.
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Burdett Oxygen Co.
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Davis-Bournonville Co.
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The Imperial Brass Mfg. Co.
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The Prest-O-Lite Co.
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United States Welding Co.
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Burdett Oxygen Co.
International Oxygen Co.
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Bermo Supply Co.
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Davis-Bournonville Co.
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Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
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Universal Oxygen Co.

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Burdett Oxygen Co.
Bierman-Everett Fdy. Co.
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The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Steel Sales Corp.
Torchweld Equipment Co.
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United States Welding Co.
Universal Oxygen Co.

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Hauck Mfg. Co.
Universal Oxygen Co.

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Hauck Mfg. Co.
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Superior Oxy-Acetylene Machine Co.

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Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.

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Vulcan Process Co.
William C. Adams

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Chicago Eye Shield Co.
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Hauck Mfg. Co.

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Bermo Supply Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
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Superior Oxy-Acetylene Machine Co.
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United States Welding Co.
Universal Oxygen Co.

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Hauck Mfg. Co.
Superior Oxy-Acetylene Machine Co.

HYDROGEN
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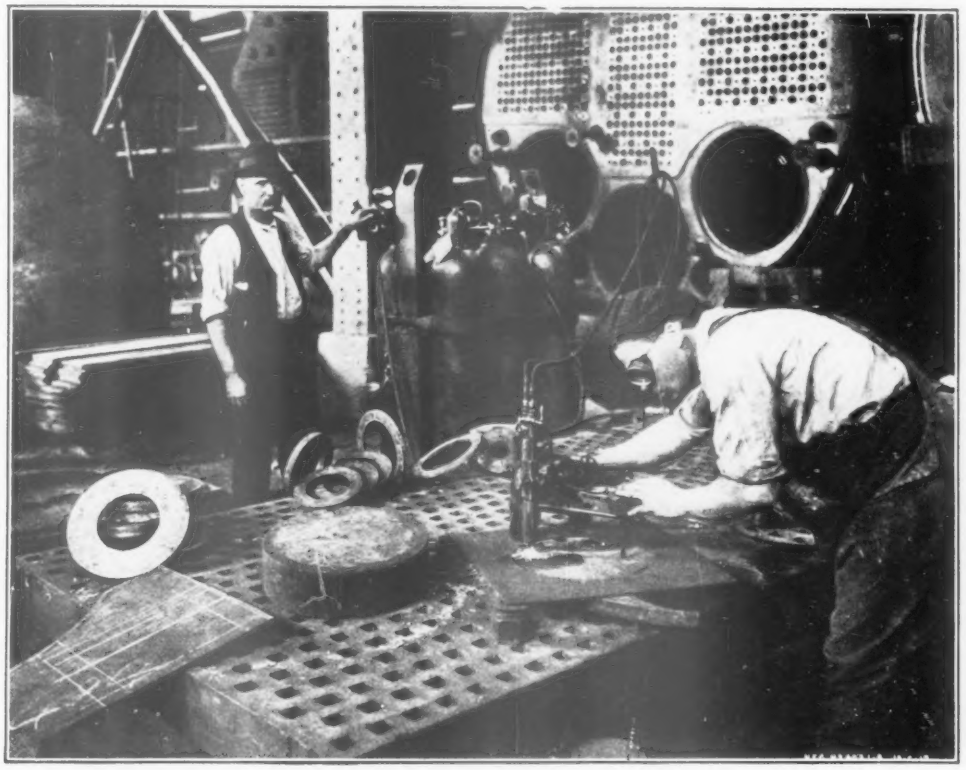
Burdett Oxygen Co.
International Oxygen Co.
Universal Oxygen Co.

The Value of Oxy-Acetylene And Davis-Bournonville Apparatus

has never been so fully demonstrated as during the past year of government preparations and demands upon the foundries, steel mills, munition plants, and the entire metal-working industry, and particularly in the great shipbuilding program.



The Radiagraph, an exclusive Davis-Bournonville development for mechanical cutting with the Oxy-Acetylene or Oxy-Hydrogen flame, in the New York Shipbuilding yard, being used for circular cutting of steel plate. Note the true and finished cut and the thicknesses of the several pieces.—Photo by New York Shipbuilding Corp.

Exclusive developments in mechanical cutting and welding with Oxy-Acetylene and Oxy-Hydrogen have been of invaluable assistance to metal workers, coupled with highest efficiency in results and lowest operating cost. The Radiagraph cuts from ½-inch to 20-inch steel plate, in straight lines or circles. The Oxygraph cuts in any direction, according to pattern or drawing, along straight lines, curves or sharp angles. Speed from 3 to 18 inches per minute, according to thickness.

"Davis Apparatus" has been continuously and effectively developed from the time the company brought the positive, independent pressure system of oxy-acetylene welding and cutting to the United States ten years ago, and is backed by the longest practical experience, greatest development, and widest application, providing portable hand welding and cutting outfits or the most complete installations with acetylene and oxygen- and hydrogen-producing and compressing plants.

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General Offices, Jersey City, N. J.

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Alger Supply Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Mach. Co.

OXYGEN (Compressed in Cylinders)
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The Linde Air Products Co.
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Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

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Davis-Bournonville Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
The Prest-O-Lite Co., Inc.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

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The Bastian-Blessing Co.
Burdett Oxygen Co.
Bermo Supply Co.
The Prest-O-Lite Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
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Burdett Oxygen Co.
Davis-Bournonville Co.
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United States Welding Co.
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Bermo Supply Co.
Burdett Oxygen Co.
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The Harris Calorific Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Messer Mfg. Co.
Welding Supply Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

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Bermo Supply Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
The Evleth-Lindsay Co.
The Harris Calorific Co.
Messer Mfg. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.

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Bermo Supply Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
The Evleth-Lindsay Co.
Messer & Co.
The Harris Calorific Co.
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The Alexander Milburn Co.
The Imperial Brass Mfg. Co.
Torchweld Equipment Co.
Oxweld Acetylene Co.
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Universal Oxygen Co.

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The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

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Air Reduction Sales Co.
Burdett Oxygen Co.
Universal Oxygen Co.

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Oxweld Acetylene Co.
See also "Torches."

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Burdett Oxygen Co.
Chicago Eye Shield Co.

WELDING (Oxygen for)
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Air Reduction Sales Co.
Burdett Oxygen Co.
Universal Oxygen Co.

WELDING RODS
Air Reduction Sales Co.
Bierman-Everett Fdy. Co.
Burdett Oxygen Co.
Oxweld Acetylene Co.
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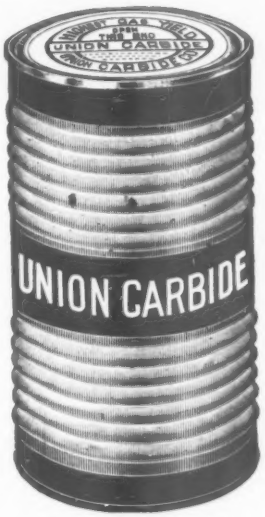

Packed in Blue and Gray Drums

Union Carbide Sales Company

New York City, 42nd St. Building — **Chicago, Ill., Peoples Gas Building** — **San Francisco, Cal., Kohl Building**

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UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

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ARIZONA
Phoenix—42 S. Central Ave.
ARKANSAS
Fort Smith—109-123 So. Ninth St.
CALIFORNIA
Eureka—109 Second St.
Fresno—932 H St.
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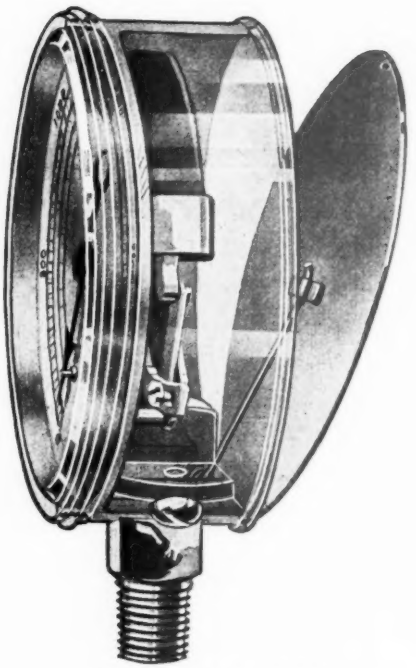

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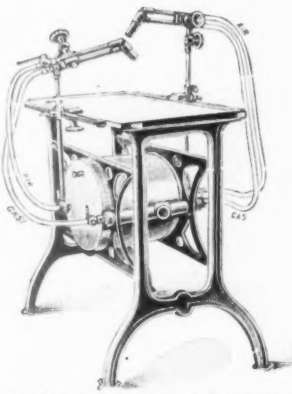

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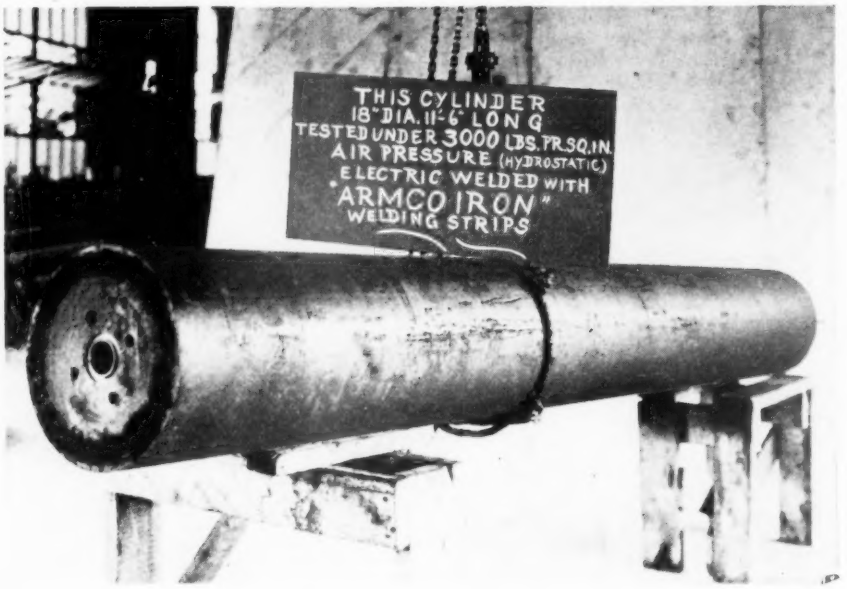

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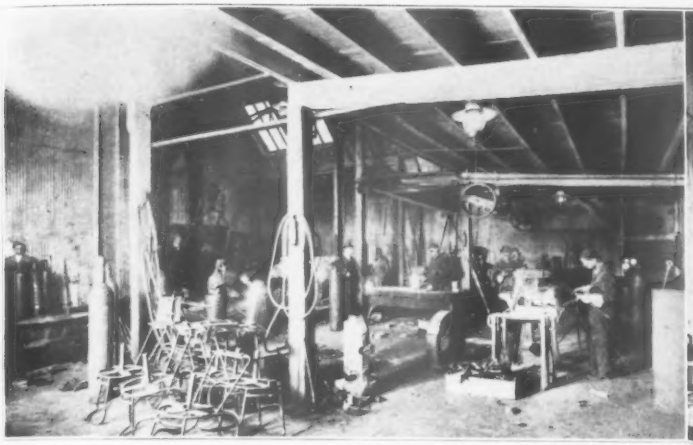

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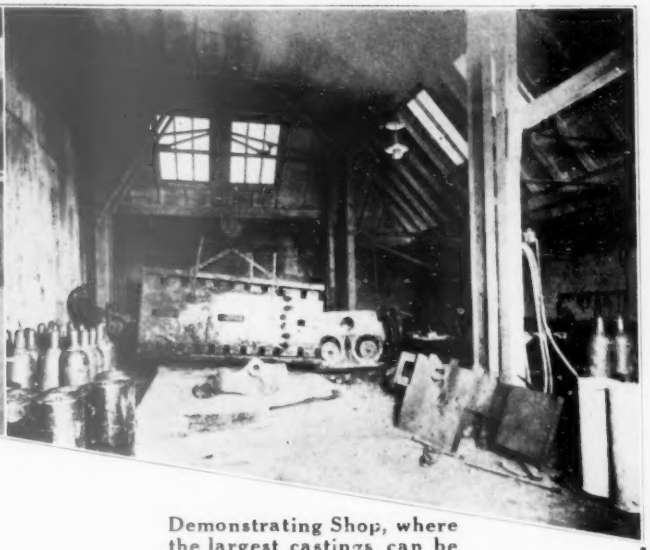

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OXY-ACETYLENE WELDING *of* COPPER, BRASSES *and* BRONZES—V.

By M. R. Amedo

Metallurgical Engineer to the Union de la Soudure Autogene. Translated, with additions by D. Richardson, Wh. Exh., A. M. I., Mechanical Engineer, Member of the Union de la Soudure Autogene

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Heat Treatment of Brass Welds.—Annealing is always valuable for the alloys containing between 65 and 70 per cent of copper. The operation of annealing is useless for the brasses containing more than 70 per cent, or less than 65 per cent of copper.

Practically, it can be said that annealing is indispensable for brasses in the first class—in other words, for the brasses that can be worked cold. Brasses in the second class should only be annealed to remove the effects of cold-hammering, a treatment always advisable for welds which have to withstand great strains. The appearance of a weld of this character is shown in Fig. 21.

The structure in the welded zone of a brass containing 65 to 70 per cent of copper is, previous to annealing, very different to that of the rest of the piece. The intense local heating by the welding flame gives to brass a "dendritic" structure similar in appearance to bronze, and this structure

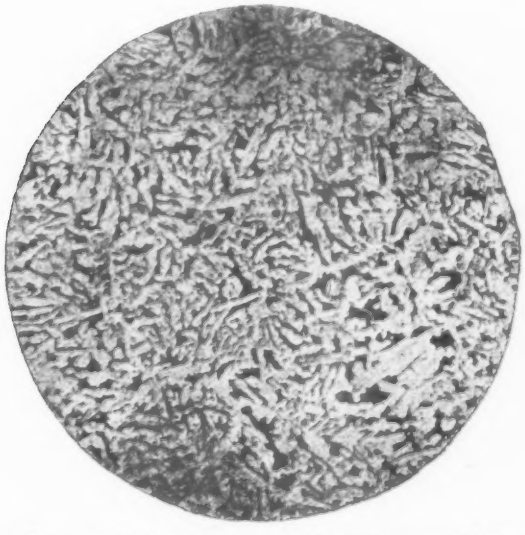


Fig. 21.—Brass containing 60 per cent of copper annealed to remove hammering effects. (Magnified 50 diameters.)

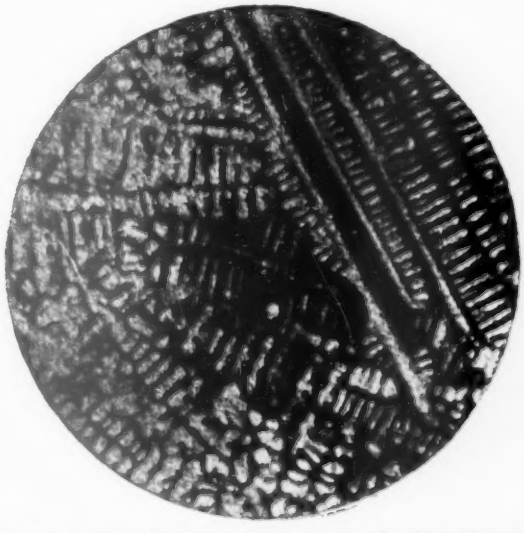


Fig. 22.—Brass containing 70 per cent copper, showing effect of blowpipe; numerous dendrites. (Magnified 100 diameters.)

is clearly developed by etching with copper ammonuium chloride, or some other suitable solution. These "dendritic" crystals, as shown in Fig. 22, are very numerous if the cooling has been regular, as, for example, in welds of great thickness—(the metal shown in Fig. 22 is taken from a weld on 6-gauge material, and is magnified 100 diameters). In the case of welds on thin material the solidification is very rapid, and the dendrites are then extremely small.

The annealing of brasses of this class makes the structure of the whole article uniform. It destroys the dendritic structure and develops small crystals. The best combination of strength and ductility are obtained for annealing temperatures between 600° and 700° Cent. (between 1112° and 1292° Fah.). The metal shown in Fig. 22, after annealing, has the appearance shown in Fig. 23.

Brass should not be annealed at too high a temperature. Annealed at 800° Cent. (1272° Fah.) the crystals become very large, as shown in Fig. 24. If the temperature of annealing is too high and the annealing maintained for too long a time, "burnt" brass is obtained, which is characterized by its feeble strength and an elongation practically nil.

Burnt brass is characterized by a serious interior oxidation; the crystal joints are strongly developed, and layers of oxide are clearly visible; also numerous pin-holes are present in the crystal joints (Fig. 24).

Burnt brass is generally present in welds which have been slowly executed or annealed by the blowpipe at too high a temperature. It is facilitated by the presence of impurities, and the importance of this factor will be seen from the point of view of the manufacture of the welding-rod. A weld made by using ordinary brass wire as a welding-rod is always partially burnt, especially so when welding a brass of the first class.

Certain metallurgists, knowing the ease with which alloys rich in copper are burnt, do not believe it is possible to weld brasses containing 65 to 70 per cent of copper. In their opinion the burning, or, at least, a very large development of the crystals in the portion adjoining the metal melted by the blowpipe, is inevitable during the welding operation. We have sometimes found that the crystals are very developed in welds executed on brass containing 67 per cent of copper, *but the burning of the metal is very rare.*

It should be noted, however, that in the majority of welds

made industrially it is impossible to obtain a large crystallization when the welds are carried out by experienced workmen, because the crystal development depends not only on the temperature of annealing, but also on the time of annealing. Although the zone of metal adjoining the molten bath is raised to a temperature near the melting point, it can only remain at this temperature for a short time because of the rapid rate at which the welding operation is carried out. After the passage of the blowpipe, the cooling is rapid owing to the radiation and conductivity. The result of hardness tests on a welded brass plate, ⅛ inch in thickness, is shown in Fig. 26.

The central impression is of interest to the welder. It shows that (*a*) after *hammering and annealing*, the mechanical properties of the welded portion are the same as that of the metal; (*b*) the metal adjoining the weld is not injured by the rapid melting by the blowpipe. Moreover, the figures showing the results of tests, which are given later, clearly demonstrate that in no case is the brass burnt.

The Welding Metal for Brass. The welding wire intended for the welding of brasses should be manufactured from *new* metals. The zinc should be of good quality, so as to avoid incorporating into the metal impurities, lead, etc., capable of facilitating the burning of the metal.

The quantity of aluminum added should be very small, because aluminum—as is shown by M. Guillet in his researches on brasses—very rapidly raises the zinc equivalent; 1 per cent of aluminum is equivalent to the addition of 3.5 per cent of zinc; this is valuable in controlling the manufacture of welding wire.

The color of the alloy is changed by a quantity of aluminum which would be considered small, especially in the case of second class brass, which has a tendency to become a beautiful golden color. A weld executed with a rod of this type is therefore very obvious, and this may be a serious disadvantage in certain applications.

The manufacture of the welding wire is an *extremely delicate* process, as the very *small amount of aluminum* present must be distributed *uniformly* throughout the metal. It is impossible, without taking very minute precautions, to obtain, with the low figure used, an homogeneous metal from the point of view of the percentage of aluminum. The manufacture should be in the hands of specialists, and should be continually controlled.

Execution of Brass Welds. Preparation of Parts.—The edges are beveled with a single or double bevel according to the thickness of the metal. A welder who operates on material above ⅛ inch thick without having previously beveled the parts invariably obtains adhesion, lack of penetration, excessive consumption of gases, burnt metal—in short, very defective welds. Careful experiments have shown that the cost of gases in the case of unprepared welds exceeds by 25 per cent the cost necessary to execute the same work properly beveled.

The angle of the bevel considerably affects the mechanical properties of the weld. If the angle is too small, or not carried to the bottom edge, it is difficult to get good penetration and to avoid adhesion in the lower part of the weld. The bevel which gives the best results from all points of view is that in which the beveled plates form an angle of 90°—in other words, the entire thickness of each side should be beveled to an angle of about 45°.

The immediate neighborhood of the weld should be carefully scraped clean. The defect of adhesion, more or less common in brass welds, is frequently due to neglect to properly clean the parts. There is no time for the flux to destroy the oxide and greasy matter which usually coat the metal, and the flame of the blowpipe does not destroy them.

Fig. 23.—Metal of Fig. 22 after annealing at 650 deg. Cent. (Magnified 50 diameters.)

Fig. 24.—Metal of Fig. 23 annealed at too high a temperature. (Magnified 50 diameters.)

In welding large articles it is advisable to preheat the environs of the weld, taking care not to raise the temperature above 930°F. (500°C.).

Power of Blowpipe.—The power of blowpipe to use should be greater than that which would be necessary for welding the same thickness of mild steel, and should be slightly higher than for welding the same thickness of copper, in order to obtain free fusion of the edges of the weld.

The actual welding operation should be preceded by heating the edges of the weld, and this can be done by the lateral displacement of the blowpipe. If this precaution is neglected, the melting of portions of the edges of the weld would be insufficient, and adhesion along the beveled edges would follow.

The molten metal is very fluid, and this tends to the formation of holes. The use of the proper welding wire containing aluminum has a marked effect in diminishing the fluidity.

The welder should avoid surrounding the parts to be welded with fireclay or similar material to prevent the molten metal running away. The usual method of supporting the work on firebricks should also be avoided, because the gases contained in these refractory materials are set free, under the influence of heat, during the welding operation, and,

owing to the fluidity of the metal, very large blowholes are formed throughout the welded zone.

Melting the Edges of the Weld.—As in the case of copper, the melting of the metal of the piece should take place without the necessity of bringing the white cone of the flame in contact with the beveled faces. If the work is of large dimensions, the heating of the edges of the weld should be sufficiently intense so as to reduce to a minimum the cooling of the beveled faces, due to conductivity, and prevent adhesion by premature solidification.

In order to avoid oxidation, it is important that no melting of the metal of the work to be welded should take place without incorporating a certain quantity of welding metal.

During the welding operation it is necessary to add regularly in the joint a certain quantity of flux, and for this purpose it is only necessary, from time to time, to dip the welding rod into the tin containing the powder.

Flux.—Borax does not give satisfactory results from the point of view of cleaning the metal, and does not possess the requisites of a good flux. A good flux for brass melts at a high temperature and insures the perfect cleaning of the metal. The powder when melted covers the molten brass, thus protecting it from oxidation, and the good joining of successive additions of metal is facilitated. The proper flux, which may be purchased from a reliable company—preferably from one making a specialty of this particular line—dissolves the oxide of aluminum which sometimes favors

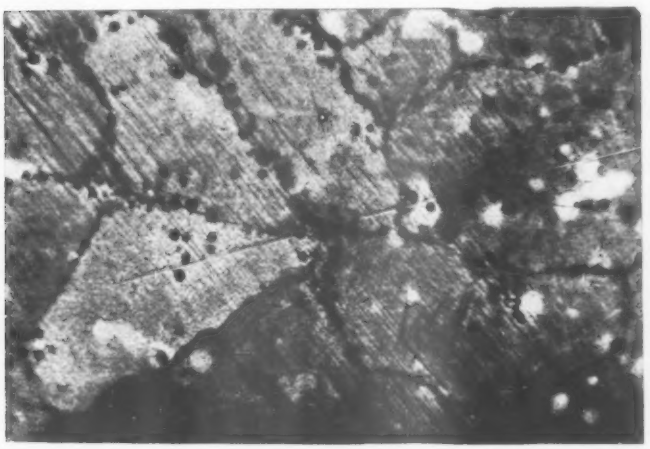


Fig. 25.—"Burnt" brass. Layer of oxide between the crystals, pinholes. (Magnified 50 diameters.)

adhesion. *To obtain sound welds, etc., the use of a flux is indispensable.*

Hammering and Annealing Brass Welds.—Hammering considerably improves the mechanical properties of brasses. It should be done cold for brasses containing 65 to 70 per cent of copper, and brasses containing 55 to 65 per cent of copper should be forged hot, *taking care not to continue the hammering after the temperature of the metal falls below 930 degrees F. (500 degrees C.), because at this temperature brass becomes very brittle.*

After hammering, brass should be annealed within the limits of temperature previously indicated.

Brass should never be dipped into cold water while hot, as this makes the metal brittle.

Mechanical Strength.—The strength of well-executed brass welds is in itself sufficient to specify the use of oxy-acetylene welding for the manufacture of various articles.

A weld on brass containing 65 to 70 per cent of copper, properly hammered and annealed, can be energetically forged or intricately stamped without showing any signs of cracks. For example, the writers have beaten out a weld, executed on sheet brass ⅛ inch thick, to a thickness of 1/100 inch thick without showing any signs of a crack either in the weld itself or in the surrounding parts. Brass welds on material up to 1½ inch thickness can always be compressed without showing cracks.

The following results of tests on welds made by a welder with little experience should be looked on as the lowest results that would be obtained by an experienced welder.

The test pieces were hammered after welding, and afterwards annealed in a coke fire.

TESTS ON SHEET BRASS.

(67% Copper, 33% Zinc.)

I.—Test-pieces Approximately 5/16 inch hick.

No. of Test.	Thickness in inches.	Tensile strength. Lbs. per square inch.	Elongation, per cent.	Remarks.
1	0.35	35,800	27.0	Broke in the weld.
2	0.35	38,400	28.0	"
3	0.36	34,300	21.5	"
4	0.31	33,400	20.0	"
5	0.33	26,600	21.2	"
6	0.35	31,400	19.1	"
7	0.35	24,700	18.0	"
8	0.35	28,900	19.5	"
9	0.35	21,300	9.5	Welded with ordinary brass.

II.—Test-pieces of 14-gauge Thickness.

No. of Test.	Tensile strength. Lbs. per square inch.	Elongation, %	Remarks.
1	26,600	12	Traces of adhesion,
2	36,100	22	Broke in the weld.

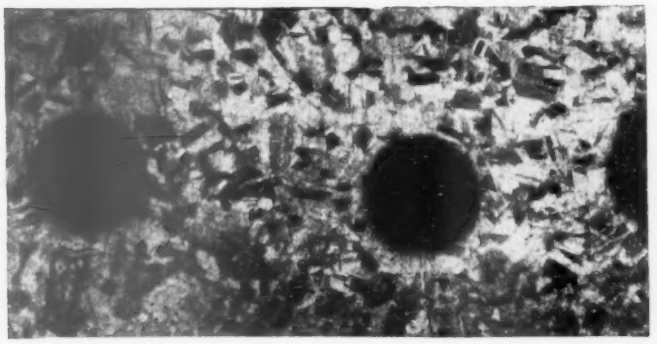


Fig. 26.—Hardness test on a brass weld and its adjoining parts. (Magnified 50 diameters.)

3	24,700	10	Blowholes.
4	29.400	19	Broke in the weld.
5	36,100	21	"
6	37,700	25	"
7	36,300	23	"

TESTS ON BRASS OF SECOND QUALITY.

(60% Copper, 40% Zinc.)

Test-pieces of 8-gauge Thickness. All the Fractures Took Place in the Weld.

No. of Test.	Tensile strength. Lbs. per square inch.	Elongation, %	Remarks.
1	27,000	10.0	Adhesion in the lower part of the bevel.
2	41,500	36.0	Regular fracture.
3	42,700	40.0	"
4	34,400	23.4	"
5	44,100	40	"
6	42,700	38	"
7	32,700	10	Partial adhesion.
8	44,800	40.5	Regular fracture.
9	40.800	37.5	"

These figures show clearly that welds on brasses done by a welder with average experience are sufficiently strong. The test-pieces given in Table II. were operated on by a welder who had very rarely welded brass.

NAVY AIR SERVICE WANTS WELDERS.

Men with practical experience in oxy-acetylene welding work are in demand for ground service in the Navy Flying Corps. An excellent opportunity is offered at the present time in order that the talents of men expert in this work may be utilized in preparing and maintaining sea planes.

After instruction, enlisted men are eligible for appointment as first and second class petty officers in the Naval Flying Corps. On the basis of ten men to every flyer, about 8,000 mechanicians will be necessary to complete the organization of the corps. Navy recruiting officers are making special efforts to complete the personnel at an early date.

Enlistment as a mechanic in the Naval Flying Corps now stationed at Great Lakes, Ill., is by application to Lieut. Lee Hamond, Naval Flying Corps, U. S. Naval Training Station, Great Lakes, Ill.

OXY-ACETYLENE IN ELECTRICAL CONSTRUCTION.

By the Electrical Engineer on the Job.

It may be of interest to relate some of the uses which the oxy-acetylene cutting torch has found in connection with the electrical construction work in a large steel mill under course of erection.

Practically all the buildings are of structural steel design. The many motors, lights and signals installed involve a great quantity of electrical wiring. All the wiring is being done in conduit and many thousands of feet of conduit must be placed.

A cutting torch was first purchased for burning holes in beams, gusset plates, floors and other steel members where the conduits might or must pass through them. It was soon evident that much bending of conduit could be avoided if direct runs through the steel work could be made. The torch made this easily possible. The saving in bending work not only represents time saved, but the direct runs make wire pulling easier and the job gives a much better appearance. Most of the conduits are concealed in the steel framing and there are no ugly bends around the joints. Of course it is necessary to exercise care to avoid weakening the steel members. For instance, in burning a hole in a beam the hole is located in the center of the web where the metal is subjected to minimum strain.

It was not long before the men learned how much more quickly and easily a hole can be burned than drilled. The electric drills met competition which put them out of the running. The torches are now used almost exclusively for burning holes for U bolts and J bolts for attaching conduits, also for all bolt holes for brackets and other attachments made to the steel. In this service the torches are proving invaluable and are saving many hours of time and many dollars of labor. The work when completed is equal in all respects to that done when all holes were drilled.

It happened soon after the torch was put in use, that a distributing cabinet of sheet steel was erected and it was found that one or two of the conduit holes provided were not in the most desirable locations for the conduit runs. The torch quickly remedied this situation by burning new holes where desired. Now all cabinet and junction boxes are purchased without holes or knockouts and the holes are burned in the field just where most desirable for the conduit runs as installed. This has proved a convenience and an effective arrangement.

For heavy soldering work the torch also finds applications. The ordinary electricians' torch makes slow progress in heating up a large lug or splice. The oxy-acetylene torch, carefully applied, will do the work in much less time. It is therefore used to supplement the electricians' torches on heavy work.

One torch was soon entirely unequal to the task. Three outfits are now kept busy continually, ever in demand and the hardest worked tools on the property.

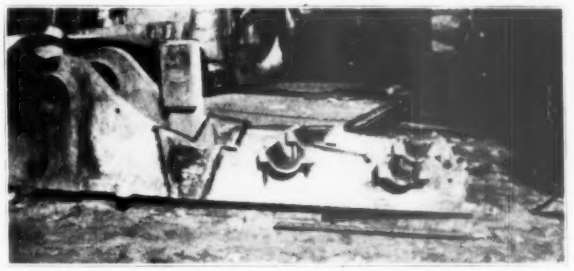
NEW ASBESTOS WELDING PAPER

A new asbestos welding paper, especially prepared for welding purposes, is being introduced to the trade by F. D. Farnum & Co., 20 West Jackson Blvd., Chicago, Ill. Ordinary asbestos paper used for welding purposes usually comes in what is termed four to six pound paper, and as every welder knows, the last couple of years asbestos has been giving off abnoxious fumes which are very injurious to the eyes and lungs. This new asbestos welding paper, the trade name of which is "Weldox," is 10 lb. paper, is made from long fibre asbestos, and will therefore stand considerably rougher usage than the ordinary paper, and at the same time will not smoke or give off fumes. Because of its heavier weight, "Weldox" will give more service.

This company is also marketing a line of mittens, aprons and other asbestos products.

WELDING A LARGE SHEAR.

Editor: This is a photo of a shear base which I welded a few months ago for Katzman Bros., of Utica, N. Y. They use it to cut scrap iron. This machine has been in active service every day on the same class of work that it was before it broke in half. Katzman Bros. were crowded to their full capacity filling large scrap iron orders when this shear broke in half. To get a new one would have delayed them so long that they would have had to cancel a lot of orders, and the new part would have cost $600. This casting weighed about 7,000 pounds. The break was 12½ inches perpendicular, 4 inches thick at the top and 8 inches at the bottom. I drilled and chipped out a "V" on casting on each side at about 45 degrees. Placed casting on I beams and



lined it up with the tram marks that I had previously made on casting when I put the two halves together before I chipped it. Then I banked the I beams with dirt to keep the heat away from them as much as possible, to keep them from expanding and moving the casting. Then I built a fire inside and outside of casting of charcoal. Before I started the fire I built an iron frame on both sides of each weld to hold the carbon blocks that I had prepared, and put them in place as the welding advanced. As it was all perpendicular welding it had to have a rectangular block of carbon. A helper and myself finished it in 36 hours, welding, chipping, etc., using 210 pounds of gray iron filler rods. After finishing we chipped and dressed the weld down, when it was cold, and the weld was as soft as could be. My outfit never suffered a bit. Tips and torches, etc., were all O. K. W. J. J. Newell.

Lieut. L. Campbell, Jr., Ordnance Corps, is stationed at the Headquarters Motor Section Instruction Schools, The Holt Manufacturing Co., Peoria, Ill. Lieut. Campbell leaves the service of the United States Welding Co. for the period of the war.

The Lincoln Electric Co. has contributed one of the foremost arc welding experts of this country in the person of Lieut. R. E. Kinkead, E. S. N. R. F. Until February 8th Lieut. Kinkead will be stationed at Reserve Officers' Headquarters B. U. S. Naval Academy, Annapolis, Md.

WELDING HELPS *the* NAVY

Efforts of Germans to Put Big Ships Out of Commission Foiled by Welding Process

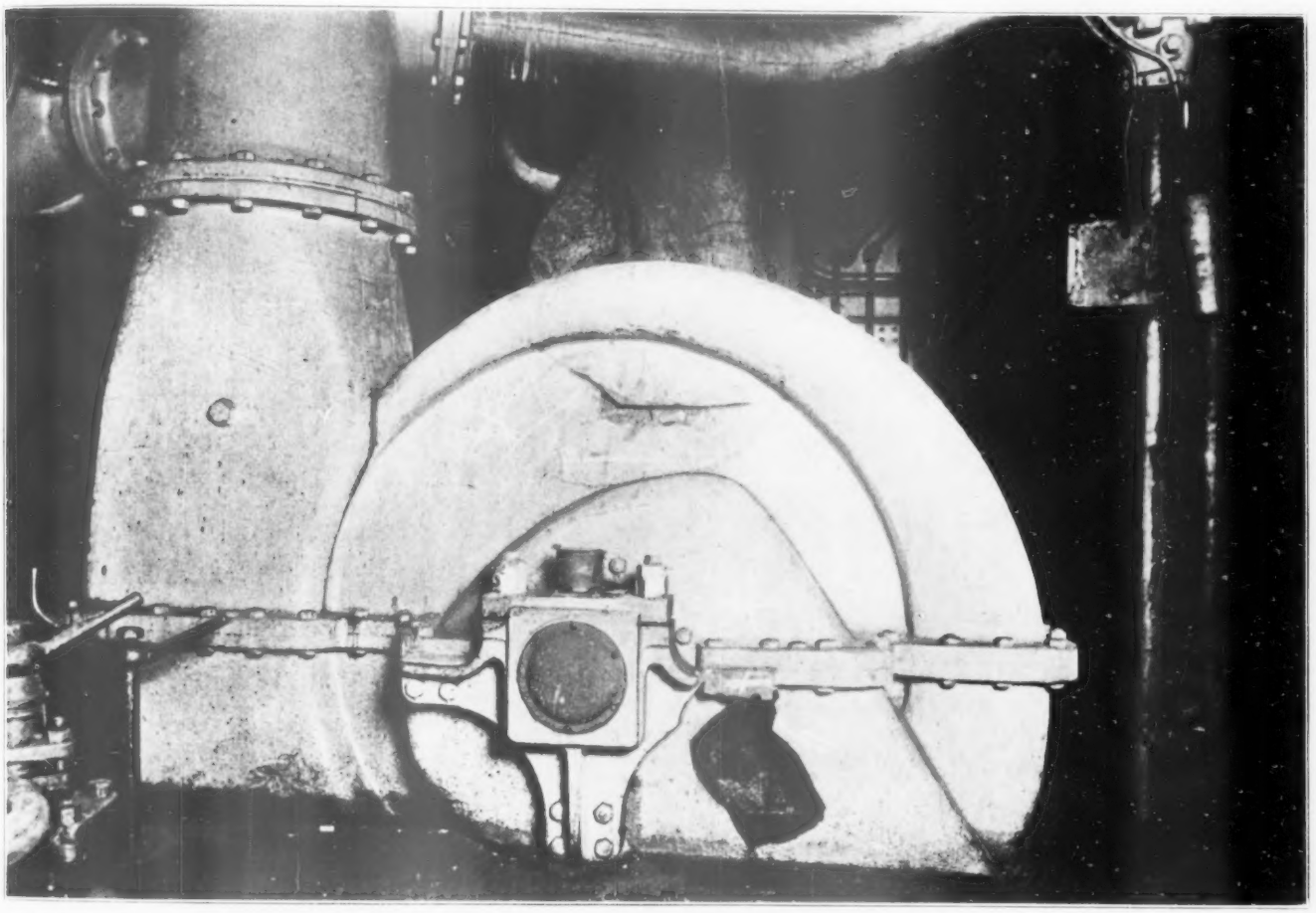
INTERNED SHIPS QUICKLY REPAIRED.

All the damage done to 109 German ships by their crews prior to their seizure by the United States government when war was declared has been repaired and these ships are today in service, adding more than 500,000 gross tonnage to the transport and cargo fleets in war service for the United States.

There is evidence that a German central authority gave an order for destruction on these ships, effective on or about Feb. 1, 1917, simultaneous with the date set for unrestricted submarine warfare, and that the purpose was to inflict such vital damage to the machinery of all German ships in our ports that none could be operated for from eighteen months to two years. This purpose has been defeated in signal fashion. In less than eight months all the ships were in service.

The destructive campaign of the German crews cunningly comprehended a system of ruin which they believed would necessitate the shipping of new machinery to substitute for that which was ruthlessly battered down or painstakingly damaged by drilling or dismantlement. There is documentary proof that the enemy believed the damage irreparable.

To obtain new machinery would have entailed a prolonged process of design, manufacture, and installation. Urged by the necessity of conserving time, the engineers of the navy department succeeded by unique means in patching and welding the broken parts and replacing all of the standard parts which the Germans detached from their engines and destroyed or threw overboard.



Typical Vandalism on the German Ships. With a Battering Ram or a Sledge the Vandals Smashed This Circulating Pump Casing, Which Was Duly Repaired by Welding.

The mechanical evidence is that the campaign of destruction was operated on these ships for more than two months and that the Germans were convinced that they were making a thorough job of it. Their scheme of ruin was shrewdly devised and deliberately executed, and it ranged from the plugging of steam pipes to the utter demolition of boilers by dry firing.

Thanksgiving Gift to Nation.

When the United States shipping board experts first surveyed the ruin the belief was expressed that much new machinery would have to be designed, manufactured, and installed, making eighteen months a fair minimum estimate of the time required. However, at the navy department, where

the need of troop and cargo ships was an urgent issue, officers of the bureau of steam engineering, having faith that the major portion of the repairs could be accomplished by patching and welding, declared it was possible to clear the ships for service by Christmas, and the last of the fleet actually took her final sea test and was ordered into service as a Thanksgiving gift to the nation.

To accomplish this end the navy department secured the services of all available machinery welders and patchers, many of them having been voluntarily offered by the railroads.

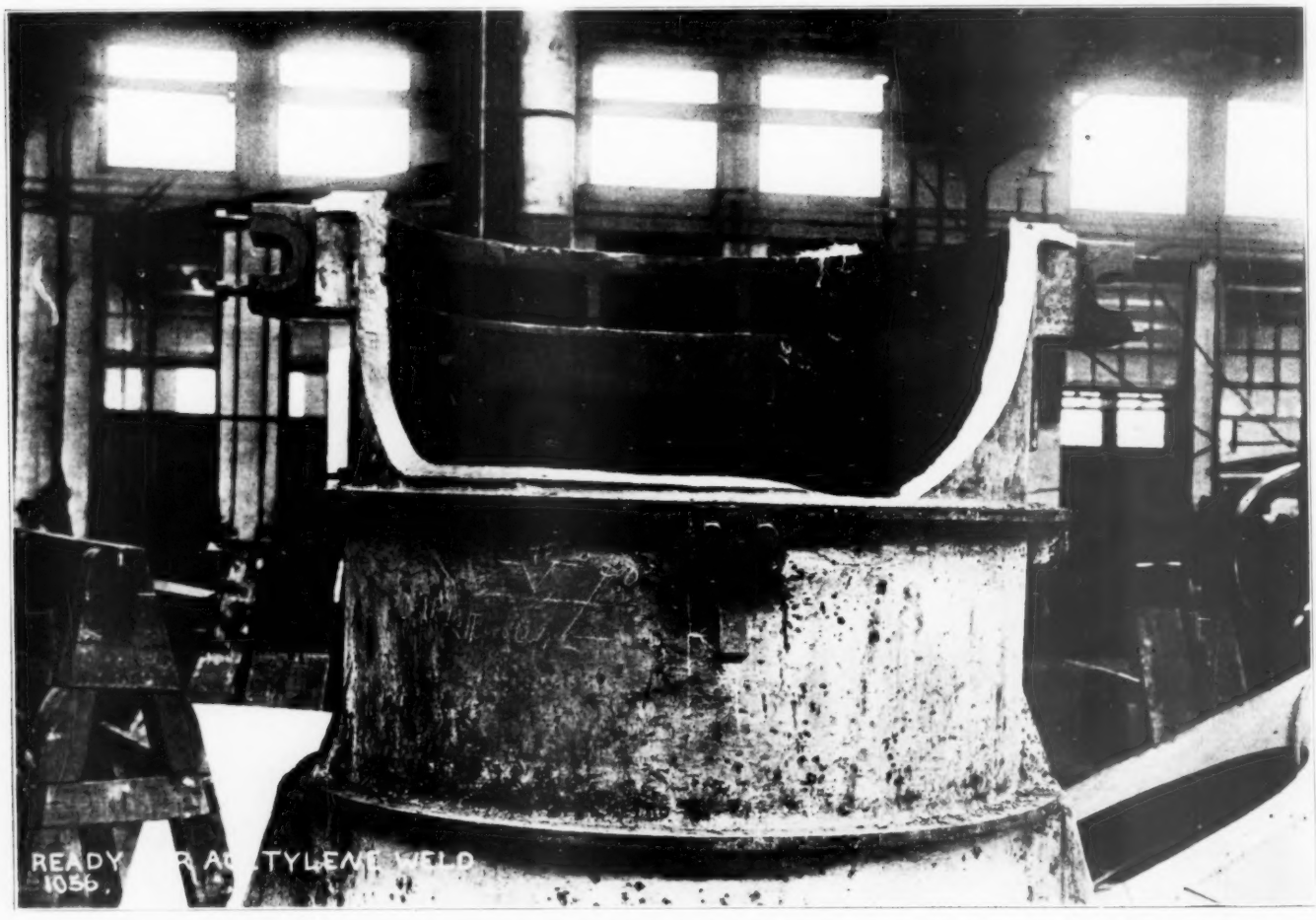
When the Leviathan, formerly the Vaterland and the largest ship afloat, was put into commission by the United States government and sent to sea for a trial, her commander, a young American naval officer, was ordered to "exert every pound of pressure that she possesses, for if there is any fault we want to know it now." The Leviathan stood the test.

Damage Similar on All.

Inspection developed the fact that the destruction on all of the ships was, in general, the same, confirming the theory that from the blows of rams. In the cases of boilers melted down by dry firing it was necessary, of course, to replace them, but in no instance did the American engineers fail to repair a broken cylinder.

In preparing the ships' cylinders for either arc or acetylene welding, the jagged edges of the breaks were first smoothed off and then beveled; wooden patterns representing the patches were then fitted to the breaks in the cylinders and cast iron or steel patches were made from these patterns. The patches were fitted to the cylinders, each properly beveled at the welding edge. The patches were then clamped to place for welding. In arc welding patches were frequently studded for the purpose of reinforcing the weld, but when acetylene welding was used studs were not employed.

The first vessel upon which welding was tried was the Armenia, which had been taken to a private shipyard for overhaul. Two nozzles on the main cylinders had been knocked off, and these were welded to place. The vessel was quickly placed in service and the cost of the repair work was about 25



Typical Break in a Cylinder. The Photograph Shows It After the Part Had Been Prepared for Welding. See Illustrations on Opposite Page (21).

general instructions had been issued to all commanding officers by the same agent. It also appeared that the parts damaged, as a rule, were those probably on hand as spare parts in the home ports of the vessels and thus, in case this country did not enter the war, the ships could again be commissioned by utilizing spare parts which could have been obtained when navigation opens to the Germans.

In breaking the great cylinders of the liner engines there was practiced a system of boring holes in curved lines and then breaking out a piece by battering the weakened point by means of a ram, rigged for the purpose. Where more delicate machinery was involved, there were instances of jacking parts until they were bent and broken. Many cylinders were cracked

per cent of what had been anticipated. The next ships repaired were the Nassovia and the Pisa, and the damage to them was found to be almost identical with that found on the Armenia.

The Prinzess Irene and the Frederick der Grosse were sent to the navy yard at Brooklyn, N. Y., for overhauling. Their engines had been as seriously broken as those of any ship. Both vessels yielded speedily to the welding process and have been for some time in transport service, experiencing no difficulty with regard to the welds.

On the Koenig Wilhelm II, the original intention was to repair the cylinders by mechanical or composition patches. The navy department, however, ordered that cast steel patches be substituted, and these were bolted to the cylinders and then

welded. The amount of fitting necessary to make a mechanical patch steam tight is shown by the fact that ten weeks after the Koenig Wilhelm II. repairs had started machinists were still at work scraping the patches to make them fit. Many of the welded patches were fitted within forty-eight hours.

On the Kaiser Wilhelm II. many pieces were broken out of cylinders, in addition to several great splits. Cast iron inserts were made and welded in place and then ground down to the surface of the cylinders.

PLAN FOR TRAINING WELDERS FOR ARMY

War Department Offered Valuable Suggestions

An excellent plan for training a large number of welders for the Army and Navy has been offered by one of the leading welding Engineers of the United States. If this plan, if looked upon favorably by the Government it should help to solve the question of where our welders are to come from.

Elsewhere in this issue we publish a call for 500 welders for the Navy, and we are told unofficially that 250 welders are required at another station. For some time past the edi-

Cylinder by Means of the Acetylene Weld. This Photograph Was Taken on the U. S. S. Antigone, Formerly the S. S. Neckar.

tor of *The Welding Engineer* has maintained that not less than 2,000 welders would be required by the Army before we win this war. If this is true then it would seem that the combined requirements of the Army and Navy will be close to 3,000 welders.

We do not believe there are 3,000 welders in the United States today who could successfully pass the Army or Navy physical examination, and furthermore, we wish to make the point that if we did have a sufficient number of young welders who could pass the examination, the shortage of *good* welders in industrial circles today is serious, and unless we wish to hamper important industries we should start *now* to create welders.

The welding industry is growing like a young weed and the one big drawback to a more rapid growth has been the lack of a sufficient number of competent operators. Welders, therefore, need have no fear that after the war is over there will be a surplus of welding talent. The demand for good men will keep pace with the supply.

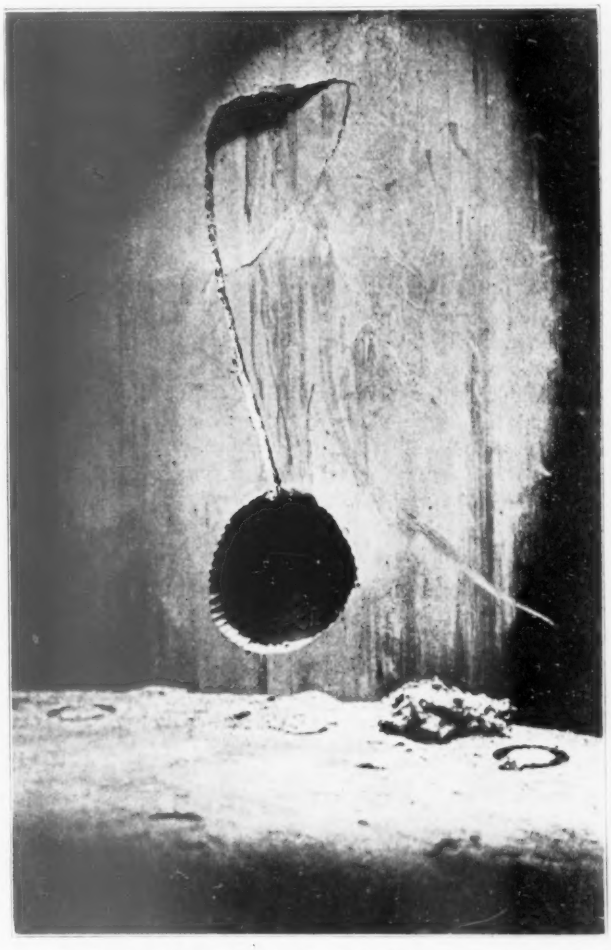
We do not know whether the War Department will look with favor on this suggestion or not, but nevertheless we would be glad to hear from owners of welding shops who would be willing to act on the suggestion.

December 7, 1917.

Quartermaster General,
Washington, D. C.

Dear Sir:—Some time ago you wrote me asking if we could furnish the names and addresses of men in the service, who were welders competent to take care of cylinders and crank cases work. I knew only one in the service, and I advised you of his name and address. It so happened that he is in France.

Since that time, three of my men received requests direct from you advising them to enlist as welders. One of them spoke to me about this yesterday, and I advised him to do



A Broken Cylinder Liner on the U. S. S. Agamemnon, Formerly the Kaiser Wilhelm II. The Photograph Shows How the Liner Was Split and the Beginning of the Process of Repair Through Welding.

so. He is next to the best man I have, and I have no doubt that he will follow your request and my advice. The only other man I have who is able to do this work is married and has a wife and two children to support. He is also my superintendent. I feel that, under the circumstances, he should not leave his family or the _____ Welding Works, because we are doing just as important work in _____ in the way of keeping the important manufacturing plants in the city going by making repairs to machinery, etc., as he could do in the service.

The _____ Welding Works is the largest welding shop

between ..... and ....., and we do work that no one else within a hundred miles is able to do. We are even doing work that no one else seems to be able to do at places as far away as Philadelphia. I, therefore, feel that it is important that the ..... Welding Works be maintained at a reasonable state of efficiency.

I have three other men who are liable to draft, none of whom is competent to do the work which you specify. It is, of course, impossible, even if I felt so inclined, which I do not, to hold these men from service to their country; but I do feel that they will be of more value as welders than in any other capacity. I am, therefore, training them intensively with the idea of making them somewhat efficient in the particular direction in which I know you need competent men. These young men are doing this work on their own time after hours, under the personal direction of myself and my superintendent.

I have no doubt that you could use a very large number of welders, and I also do not doubt that the demand will increase as more of our forces are sent to the other side. Welding is considered by those who are not welders as an exceedingly easy matter. It is placed on the same basis as running an automatic machine, and it is thought that very little intelligence and skill is required to make an efficient welder. As a matter of fact, years of experience has taught me that this is untrue. The welding of a badly broken cylinder or crank case is an exceedingly difficult matter, and not everybody can learn it. Even the best welders in this line are, at times not able to get good results the first time; and we have had a few cases where we have found that the job could not be done. The matter is not only learning to melt metal with a torch, but taking care of the expansion and contraction strains, and of leaving the piece fit to use after the work is done. It is of no use to spend time welding a cylinder if it will be so badly warped that it cannot be used, and the same thing is true of a crank case. It is usually not possible to machine either of these pieces, and as the work is generally rather slow, much time is lost if it is not done right in the first place.

I do not believe that there are, in the United States, sufficient welders to do the work which will be required. You can find plenty of men who have welded automobile axle housings day after day, and who believe for this reason that they are welders. I have had some of them in my own shop, and they are absolutely useless until they learn how to do the work. Even the work that they have done (for example, rear axle housings), we get many cases of to weld, i. e., work turned out by manufacturers which, in time, has to be done over again, because of defective work. Knowing the need of competent men in these lines, I have, as stated above, arranged to instruct these men specifically in these lines of work, and I am also going to appear before the Exemption Board when their cases come up and see if I cannot arrange to have them exempted temporarily until such time as they are reasonably competent in this work. Of course, I may not be able to accomplish this.

It has occurred to me that if you want sufficient men, expert in this line of work, you will be compelled to do the same thing that was done because of the lack of officers, which was to train them specifically for that work, and I believe the sooner such training is started the better. To this end, I have the following plan to suggest:

That various concerns engaged in this work be requested to do as I am doing, and in addition, take into their shop whatever number of men they can handle, already in the service, who know something about welding, and intensively train them in this work. I should be glad to take three or four such men and put them through a course, which will give them all the information that I have. I shall be glad to furnish all materials and the necessary instructions for the purpose, at no expense to the government. I do not know that such a plan could be carried out; i. e., whether it would be permissible.

The time it would take to instruct the average man so that he could make pretty nearly every repair to a cylinder would, I judge, be about one month. The matter of crank cases is a more difficult one because of the nature of aluminum of which they are generally made. The training would consist of work on actual cylinders and crank cases which we can obtain from the scrap yards in ..... My suggestion would be that such men could be trained carefully and accurately, and that they then would be able to instruct others, so that it would be only a short time before a very large number of welders would be ready for the work.

I am willing to devote my time to this to whatever extent is necessary to make it a success, and I have no doubt that there are others who would be glad to do the same thing.

The time required to break a man into this work would depend on several things:

FIRST: On his previous experience.
SECOND: On his natural receptiveness.
THIRD: On his mechanical skill.

As a matter of figures, supposing you were to find in the country fifty shops which would be willing to go into such a plan, and that the average man would require a month to become skilled enough to do cylinder repairs by himself. This will give, let us say, 100 competent instructors, because all men capable of welding or other work are not good instructors. These men could readily instruct, if their time could be devoted to it, five other men. At the end of the month, you would have five hundred welders, and it is easy to see that in a few months you would have more than is necessary.

The —— Welding Works is second to none in the United States in the knowledge of the principles and practice of welding, and I feel sure that the scheme is feasible if it is permissible.

There may be other special lines of welding for which the same plan could be followed, and it should be remembered that because a man is expert in these two lines, he is not necessarily so in others such as the welding of heavy castings or steel. Of course, the principles involved are the same, but the method of doing work on various metals differs considerably, and experience is required in order to make good welds.

I am sending you, under separate cover, a book in this connection, which may be of some interest to you if you have time to look it over. It shows some of the possibilities of welding.

I would be glad to hear from you if such a scheme could be carried out, and desire to assure you of my heartiest co-operation in this work.

The name of the writer of this letter is omitted, at his request.—(Editor.)

A LETTER TO THE EDITOR ON THIS SUBJECT

Editor: Referring to above letter, I rather imagine that there are fifty shops in this country who can give good instructions in welding. The Davis-Bournonville Company, the Oxweld people, the Henderson-Willis Company, and a large number of other apparatus manufacturers, with whom I am not familiar, should be able to do considerable in this line. There are, scattered through New England, a large number of shops, who make these repairs. There are quite a number of them in New York City, who are successful at this kind of work. Chicago has good shops, among them the Davis-Bournonville branch.

Of course, there will be errors made and more or less confusion, but such matters could be co-ordinated later, after the men had received a large amount of instruction, and had learned to do the most of the work. It is after all a question of experience and initiative, and a man should not be asked to do the most difficult work at first.

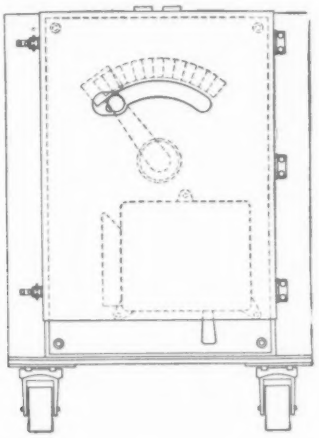
The best way to handle the thing, it seems to me, would be to select such men as have had some experience in these lines and train them to do the more difficult jobs; then set them to training other men as fast as they become competent. It will require, for the best results, a careful organization, which can only be developed in time, as the relative skill of the men is made evident. I have no doubt that apparatus could be obtained from the manufacturers, even if it were only loaned for the purpose.

I would not attempt to outline at first any course of instruction, but permit each shop to follow its own methods so long as they produce results. After the work was started, it might be well to begin on a standard course of instruction. What I had in mind was to take an old cylinder and break it up with a hammer; for example, breaking lugs off as a beginning, as this is the easiest to repair. Then break the jacket and repair it; finally breaking the dome out and replacing it. The same method could be used in regard to crank cases of both cast iron and aluminum. Any man that can learn to make these repairs satisfactorily can learn to do any light work that is necessary to be done on cast iron or aluminum; and it is not very much of a job after that to learn to weld steel. He has then a basis for future work of other kinds.

Portable Outlet Panels for Electric Welding Service

For an electric welding outfit to be of its maximum service, it must be so arranged that it can be taken to the work, no matter where that may be located. For instance, in a railroad shop there should be outlets adjacent to each stall in the roundhouse, one or more on the washing tracks outside and others in places throughout the shop. In a boiler shop there should be an outlet on every other column and in a large machine shop there should be an outlet adjacent to each of the larger machines, in order that work may be done in filling up blow holes and other defects on large castings with the minimum amount of crane handling.

One solution of the problem would of course be to locate a panel outlet of a suitable type wherever it is anticipated that



electric welding might be desired. However, this is rather an expensive proposition and many electrical engineers would prefer to accomplish the same result in a simpler manner. A recently developed portable outlet panel manufactured by the Westinghouse Electric and Manufacturing Company takes care of this situation with a minimum of expense and with all the simplicity of the familiar distributing system for storage battery charging.

Two types of portable outlet panels are furnished, both being mounted on light trucks. They consist of a control panel mounting a handle trip railway type circuit breaker having overload release with magnetic blowout, and a 13-point face plate connected to a resistor mounted in the rear of the panel. The face of the panel is protected by a metal cover through which the handles of the rheostat and circuit breaker project. The resistor is made up of grids and is protected by a cage of expanded metal. Type E panel is intended for metal electrode welding only, having a capacity of from 80 to 170 amperes. With this outfit one metal electrode holder and one shield are supplied. For a wider range of work a Type F panel should be used. This will handle metal electrode work from 80 to 160 amperes, and light graphite electrode work up to 300 amperes. The outfit includes one metal electrode holder, one graphite electrode holder and one mask.

In installing an electric welding system using these portable panels, the best method is to place a Westinghouse arc welding motor generator set at some central point. Where suitable low resistance ground connection can readily be made throughout the shop, as for instance, where metal floors or cast-iron bedplates are in general use, or in a railway shop where the track system can be used, only one connector need be extended to the various receptacles. The iron floor plates may be arc-welded to each other and isolated sections tied together by an iron rod or heavy copper cable, while the track rails may be bonded by arc-welding the fish plates to the rails. Receptacles should then be provided at suitable points throughout the shop of a capacity appropriate for the service for which they are intended. These receptacles may readily be mounted out of doors if they are provided with protection from the weather. Only single pole receptacles and a single wire cable to the portable panel need be provided. This cable should be of sufficient length so that the panel may be placed as near as possible to the work in order to save steps and valuable time for the welding operator. The flexible cable leading from the panel to the electrode holder should be as short as is consistent to the class of work to be done.

Where metal floors or tracks are not available, the ordinary two-wire system of distribution with double-pole outlets and two-wire cables should be provided.

PRESERVING HOLES

Editor:

The break to be repaired which we had in mind at this time was a cast iron wheel, a portion of the shoulder next to the shaft being broken out in the shape of a V requiring it to be filled up which could not be done without re-boring unless something was inserted in the shaft hole against which the new cast part could be built up. We are told that carbon rods are not successful for this purpose—in fact, a Cincinnati welder who does a lot of this kind of work advises us that carbon rods were not practical, yet no substitute was offered (except re-boring). Any information along this line will be appreciated.—The C. C. Fouts Company.

Answer—Very often in the welding industry it is necessary to preserve threads or holes and a substance is used which is heat resisting to a large extent and to which the molten iron will not fuse. Graphite or carbon blocks or a mixture of clay, graphite, etc., are used for this purpose. In referring to the substance we usually say a "carbon block." It does not follow that it is necessarily carbon but any of the apparatus manufacturers sell rods and blocks composed of various materials for this purpose.

In your instance, you may if you wish secure a discarded crucible from one of your local foundries and saw or cut a piece from it to fit over the part of the hole which you wish preserved. It is not necessary that you completely fill the hole; simply back up the welded area.

There are a lot of workmen in any line who maintain that things are not possible but it is always well to try things out yourself before accepting someone else's say-so that they cannot be done.—Editor.

TEST DEPARTMENT

Final Report of Test Welds Recently Submitted to The Welding Engineer—Pieces of 2x1/2-inch Tank Steel Were Furnished Applicants—Details of Plan Will Be Found in the November Issue

The first thing done was to examine the specimens carefully with a small magnifying glass, and the general appearance is described in the table. The piece was next ground off to the same thickness as the original metal and clamped to an anvil with the bottom of the weld at the edge of the anvil, and bent over by successive blows of a twelve-pound sledge. Care was taken to round the edges at the point of bending to about 1/8-inch radius to avoid starting a crack at the sharp edge. A number of specimens broke under this treatment before they had reached a right angle bend. Others stood the bending until the sides were parallel, and the amount of such bending is indicated on the sketch attached. Such as did not break under this test were reversed, and, in every case they broke at the first blow.

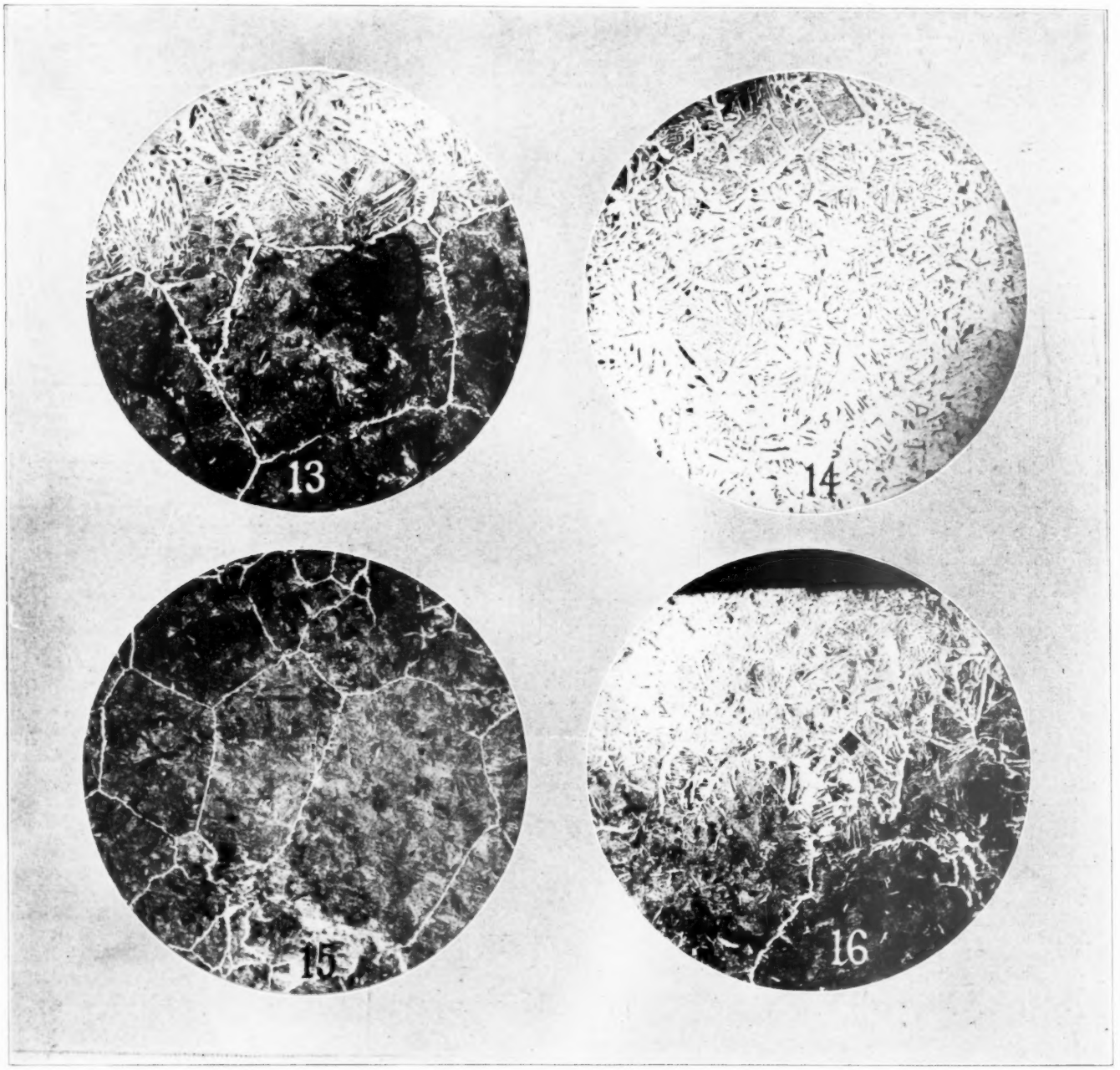


Fig. 13.—Test Piece No. 29. On Line of Weld Dark Grains Show Weld. Notice Great Size of Grains and Their Dark Color. The Latter, With Their Narrow White Border, Shows a Large Amount of Carbon in the Weld. Mag. 430.

Fig. 14.—Test Piece No. 29. In the Original Metal, Just Next to Weld, Which Is the Dark Part at the Top, the Grain Size Is Much Larger Than in the Original Material, and Is Caused by the Heat. The White Polygons Are the Grain Boundaries. Mag. 50.

Fig. 15.—Test Piece No. 29. In the Weld. Large Grain Size and High Carbon. Mag. 50.

Fig. 16.—Test Piece No. 29. Top of Face of Weld. Material Decarbonized at Top, as Shown by Less Dark Material. Mag. 50.

An examination of the fracture was carefully made to notice any defects that might exist, and in all cases where the weld was noticeably defective nothing further was done, the idea being that it is useless to make any further tests of a weld not sound. The idea is that what is wanted to determine is how to make a sound weld, and if the welders are to obtain good results this is the first thing they must strive for. After they are successful in this direction further examination should be made of the qualities of the weld which cannot be determined by the examination of the fracture with a hand glass.

In the cases where the welds appeared clean and sound the examination was carried further by polishing and etching a section and examining it under the microscope. In some cases this disclosed imperfections that should not exist and which detract from the strength of the weld.

It is rather curious to note that only one of the welds passed the entire series of tests. This is No. 30. It is one of the best welds we have ever seen, and the welder is to be congratulated on his success. It appears to be perfectly sound mechanically, the only imperfection being the large amount of oxide, which is referred to in the detailed report.

Photographs were made of all the fractures full size, but they do not show as much as one would like. It is, however, not possible to photograph an irregular surface like a fracture and get satisfactory results. One's eye adjusts itself to differences in distance, but the camera does not. There are shown by these photographs, however, the more serious defects.

Photographs were also made of the eight pieces whose fractures appear sound. These photographs show the sections made for microscopic examination. They are some-

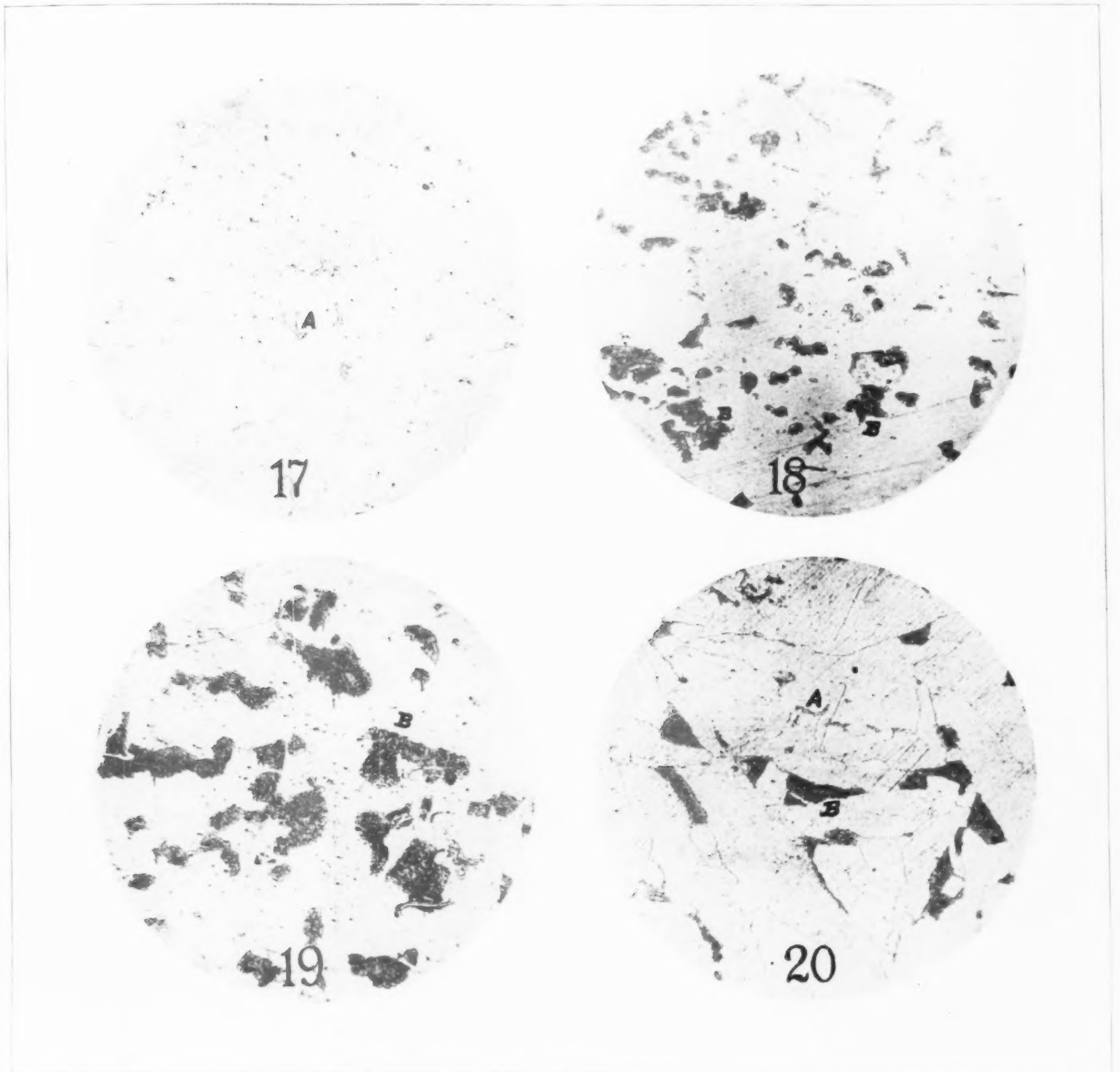


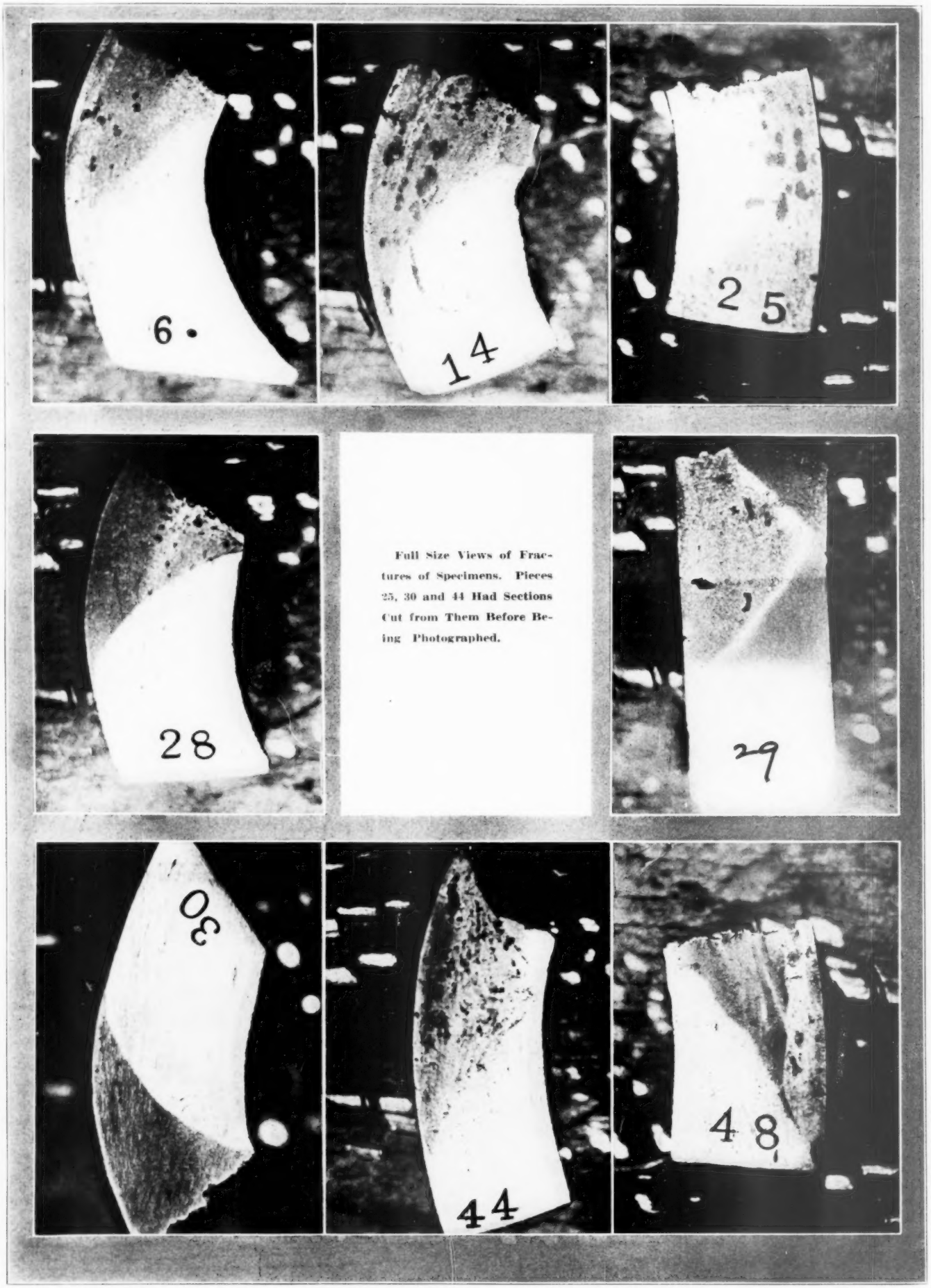
Fig. 17.—Test Piece No. 6. (Wire). Typical of Low Carbon Steel. "A"=Cementite. Etched for Grain Size. Mag. 200. Carbon About .06%.

Fig. 18.—Test Piece No. 25. (Wire). "B"=Pearlite. More Carbon Than No. 6 (Fig. 17). Carbon About .25%. Mag. 200.

Fig. 19.—Test Piece No. 29. (Wire). Carbon About .4%. Carbon Much Less Than in Welds. Mag. 200.

Fig. 20.—Test Piece No. 20. (Wire). Carbon About .15%. Etched for Grain Size. Mag. 200.

Information relative to the Test Department will be furnished on application.

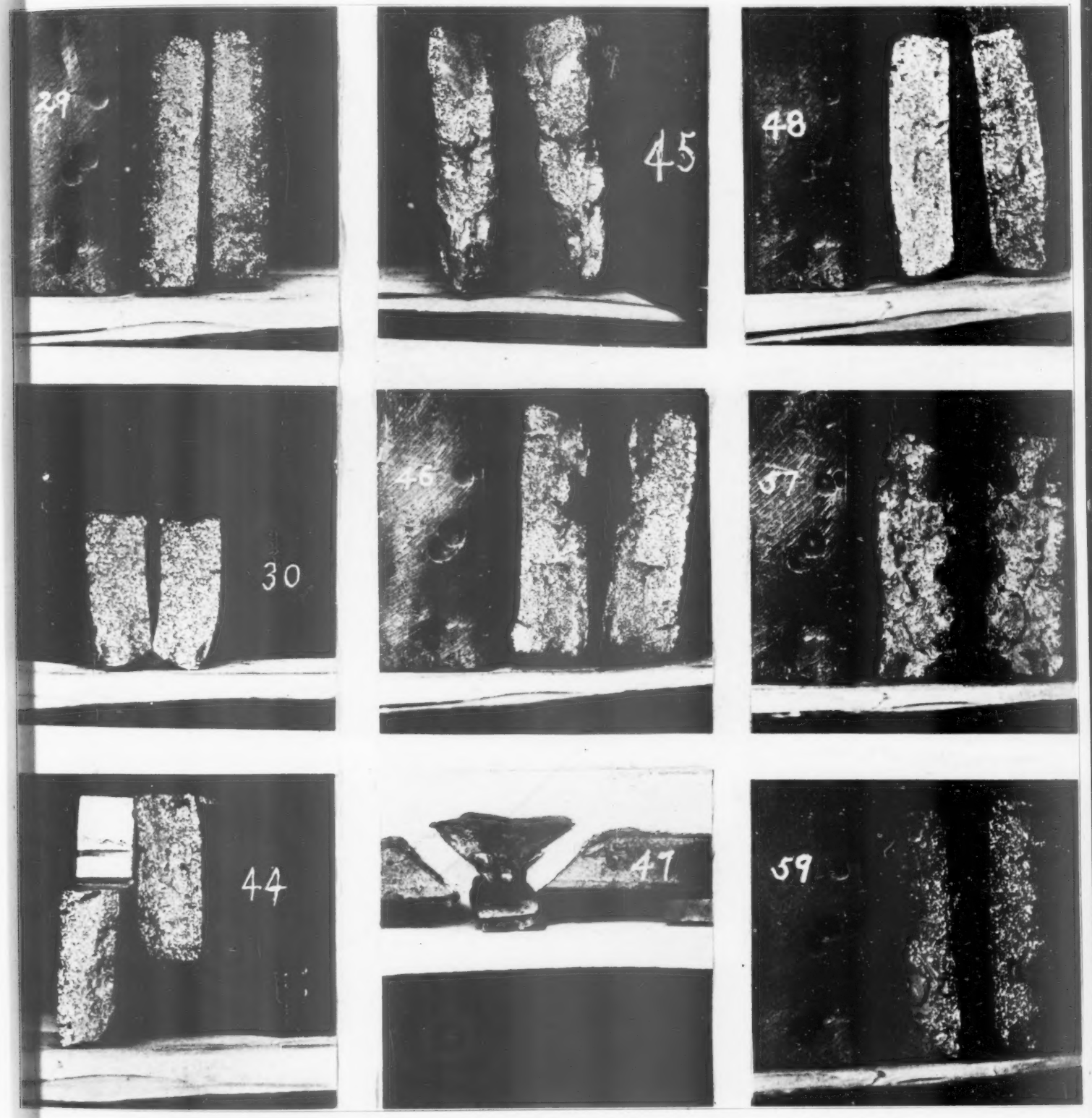


Full Size Views of Fractures of Specimens. Pieces 25, 30 and 44 Had Sections Cut from Them Before Being Photographed.

what magnified in order to show the defects, if any exist, and it will be noticed that even at this low magnification there are quite a number of prominent defects which the etching has brought out quite strongly in some cases. The dark parts of the specimens in all cases, except No. 29, indicate, we believe, more or less oxidation, due to very small spots of oxide which are microscopic in size. The microscope confirms this in all cases.

It will be noticed that in a number of cases the microscope shows laps which, while small, are in most cases quite numerous, and which would seriously affect the strength of a weld on tensile test. They are due to not floating the dirt to the top of the melted metal.

The full size photographs of the sections are published herewith, together with the table descriptive of the results of the examinations, and the curves to which the pieces bent.



Full Size Views of Fractures of Specimens. Nos. 30 and 44 Had Sections Cut Out Before Being Photographed.

There are two cases that deserve special mention, Nos. 29 and 47. No. 29 was very brittle, but it did not break through the weld entirely. It was welded with high carbon

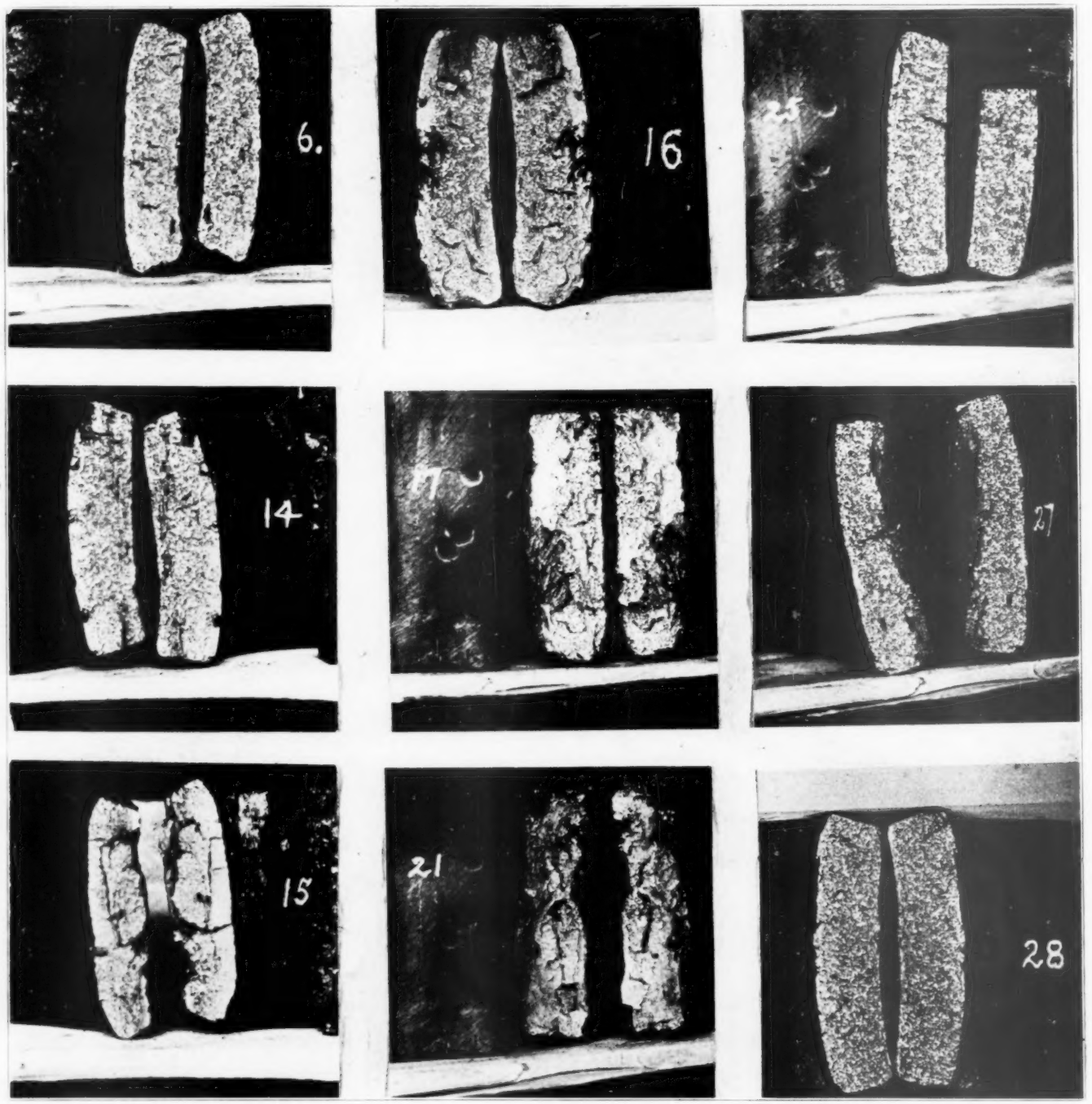
steel wire, probably drill rod. The union between the original and added materials was good, but such welding wire is valueless, as it is readily burnt. This shows very clearly in the fracture at the top of the weld, which, for about ⅛ inch was very porous and weak. Such a weld would not have stood any reasonable test when made up into some product and undoubtedly, if put into service, would have fractured, with possibly bad results.

No. 47 was the worst weld submitted. It was made with a No. 2 tip and a Neagly torch. We are not familiar with this torch, but the size of tip is evidently entirely too small to use for this thickness of metal, as neither side of the V was melted at all. The tip was not even large enough to melt the wire. It was not necessary to grind this piece off or use a sledge on it, as it broke by tapping it on the floor four times along one side of the V. The added material was also knocked loose by six blows with a light hammer. Apparently the welder who made this piece is new at the business or is not accustomed to handling this sized material.

One of the most serious defects in the defective welds was not going through the bottom of the V. In some cases there was as much as ⅛ inch that was not welded at this point.

The next most important defect was laps in the weld, i. e., places where the added material had been dropped into the weld without melting it to the preceding added material.

Both of these defects are easily avoided with care, and should not exist in any good weld, there being no excuse for them.



Full Sized Views of Fractures of Specimens. No. 25 Had a Section Cut Out Before Being Photographed.

Specimen No. 48 is apparently the only one that was welded with anything except either wrought iron or ordinary steel wire, and we should judge that the material used is vanadium steel, although this is not certain from the examination. This material is more difficult to weld with than ordinary steel, more care being needed to keep the weld free

from laps. It should, however, give a cleaner weld. In the case of No. 48, not only is the weld badly oxidized, but a structure is found in it, shown by the microphotographs as narrow black lines, which does not exist in any good oxy-acetylene weld; at least we have never seen it in such a weld. The nature of these lines is, at present, under dis-

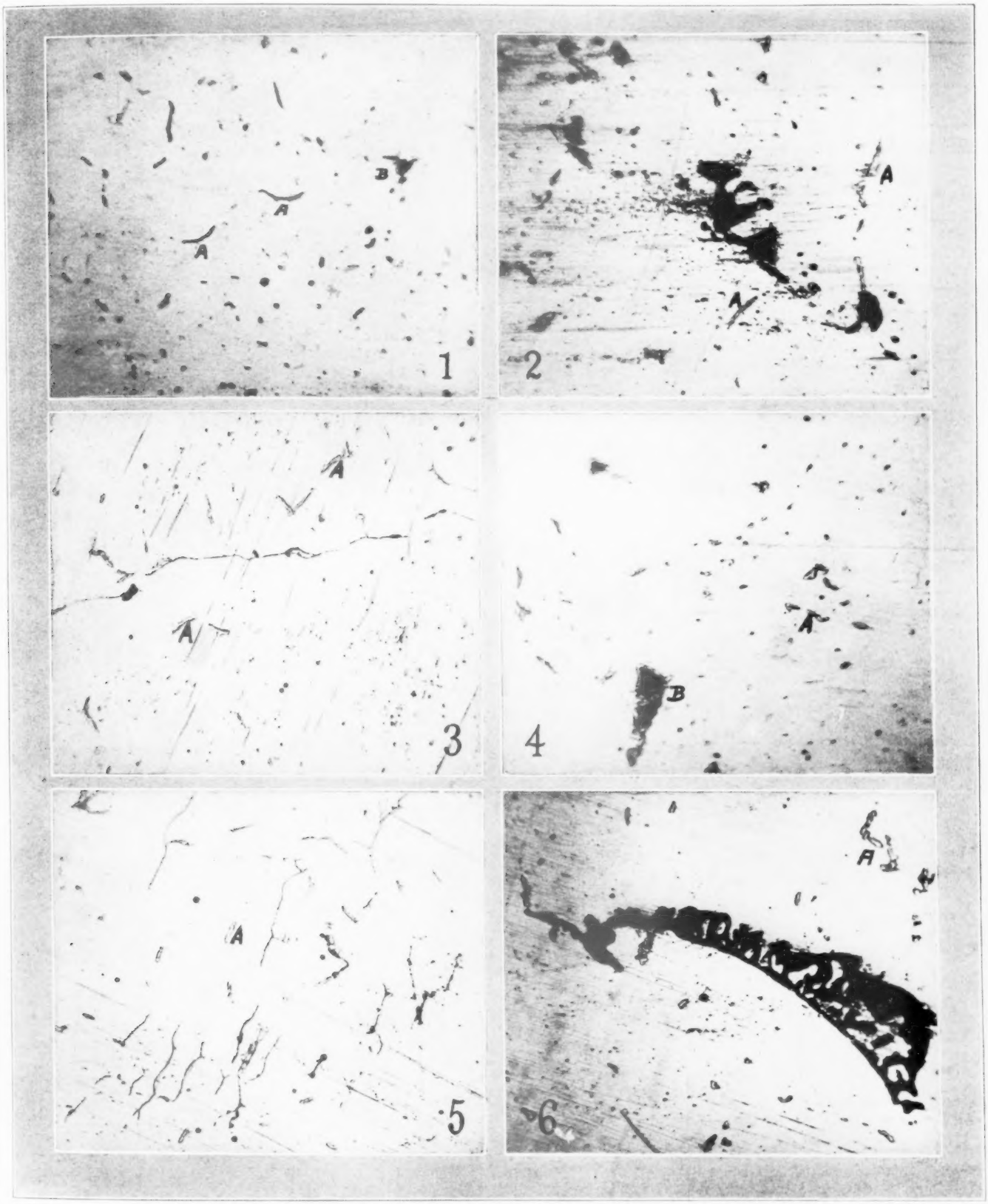


Fig. 1.—Test Piece No. 6. Black Specks Show Oxide. "A" Indicates Cementite-Carbide of Iron, Which Contains All the Carbon in the Steel. "B"—Spot of Pearlite (Cementite + Ferrite (Nearly Pure Iron) Mixed. Magnified 430.

Fig. 2.—Part of a Lap in Weld. Black Spots and Dots Indicate Oxide. This Weld Has in Top 3/16 Inches of It, Same Structure as Test Piece No. 48 (Photos Nos. 10 and 11), but the Lines Are More Numerous. Mag. 430.

Fig. 3.—Lap or Adhesion Along One Side of V Shown by Dark Line. Black Specks Are Oxide. This Weld Is Quite Free From Oxide. Mag. 430.

Fig. 4.—Test Piece No. 25. "B" in Weld Indicates Pearlite or More High Carbon Than Is Usual in Welding Rod. Note Absence of Oxide.

Fig. 5.—Test Piece No. 28. Dark Lines Are Laps. This Weld Has Many of Them. Mag. 430.

Fig. 6.—Test Piece No. 28. Slag Just Next to Line of Weld. Much Oxide in This Weld. Mag. 430.

cussion, and it is to be hoped that their nature will be determined accurately. Whatever they are they add to the brittleness of a weld and, as they can be avoided they should not exist. It should be understood that these lines exist, at times, in welds made with other material than vanadium steel. In fact, we have never seen them in good welds made with vanadium steel. This same structure is noticed in number 14, the upper 3/16" of the weld containing same.

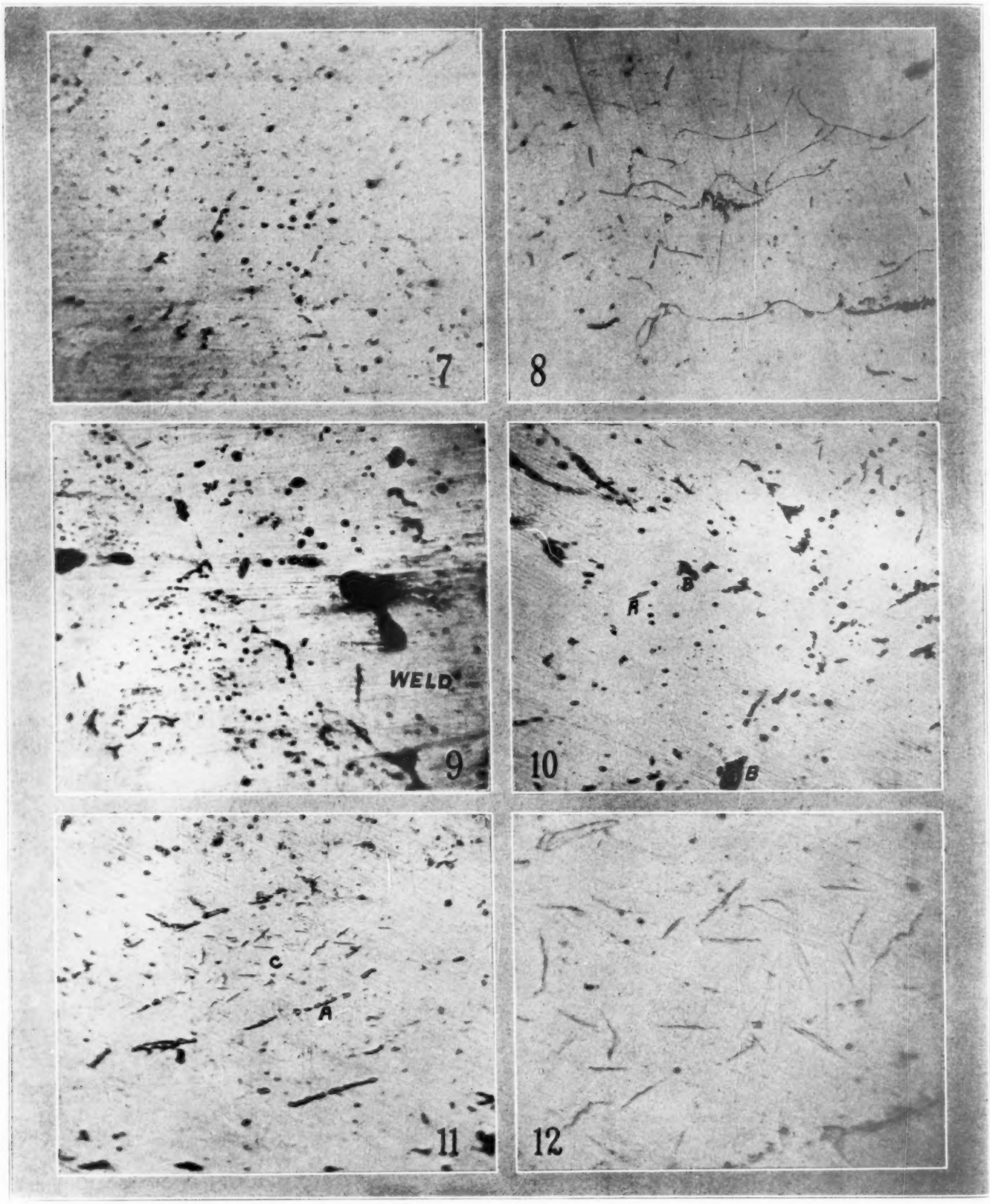


Fig. 7.—Test Piece No. 30. Notice Large Amount of Oxide in Weld. This Is Only Bad Point About Weld. Sometimes Caused by Excess Oxygen Flame. Mag. 430.

Fig. 8.—Test Piece No. 44. Large Number of Laps in Weld. Mag. 430

Fig. 9.—Test Piece No. 44. On Line of Weld, Which Is Crooked Line Running Diagonally, Showing Bad Union. Black Spots and Dots Show Oxide. Mag. 430.

Fig. 10.—Test Piece No. 48. In Weld Notice Cementite, Pearlite Oxide. Mag. 430.

Fig. 11.—Test Piece No. 48. Peculiar Structure Around "C." Much of It in This Weld. Fig. 2 Has Same Lines.

Fig. 12.—Test Piece No. 48. Same as Fig. 11, but Mag. 1,200.

WELDING WIRES USED

The following is the description of the wires as shown by the microscope.

Numbers 28, 30 and 44 were very low carbon steel, containing a considerable amount of oxide as small round dots.

Numbers 6 and 14 were low carbon steel, containing about .08 per cent carbon.

Number 25 shows a considerable amount of cementite, which is due to the method of making the wire. When this wire is normalized, it shows about .25 per cent carbon. Normalizing consists of heating the steel to about 1,800 deg. F. and allowing it to cool slowly. This is a much larger percentage of carbon than is usual in welding wire, which ordinarily contains less than .10 per cent.

The most curious specimen in the lot is number 29. This wire shows about .4 per cent carbon. In the original condition, the carbide of iron does not exist as pure cementite as in number 25, but as a part of the pearlite, although the pearlite has passed its well developed stage. Of course this condition exists

Table of Tests

Test Department The Welding Engineer.

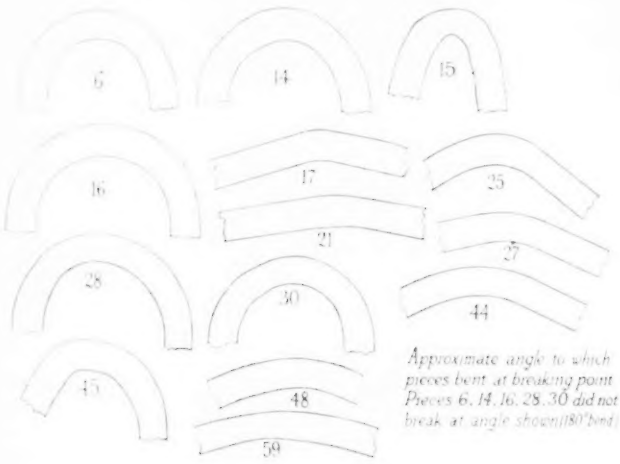
For Details See November (1917) Issue.

No. of Test Piece.	Torch Used.	Tip No.	Size and Kind of Wire Used.	Width of Weld, Lengthwise of Piece.	Through at Bottom of V.	BEND TEST BLOWS: To Crack.	BEND TEST BLOWS: To Break.	BEND TEST BLOWS: To Break on Reverse.	Appearance of Fracture.	Remarks.
6	Oxweld	10	3/16"	1 3/8"	Yes	—	29 N. B.	1	Clean and sound.	
14	Oxweld	Not Given	1/4"	1 7/8"	Yes	22	30 N. B.	1	Top 1/8" porous and dirty. Lap across weld 1/8" from top.	At 22 blows many small cracks showed, a bad indication.
15	Oxweld	10	1/4"	1 3/8"	No	9	28	1	Full of small laps, and some large ones.	9 blows broke lap open, but edges held till 28 blows. This is cause of short bend radius.
16	Prest-O-Lite	4	1/8"	2"	No	—	29 N. B.	1	Not welded through by 1/8". One side at V not welded for 3/8"	Tip too small.
17	Davis-Bournonville	9	1/4"	1 3/8"	No	2	7	—	Only half of section welded, and this has a number of laps.	Top of weld badly lapped. One side of V broke loose at 2nd blow.
21	Vulcan	9	1/4"	1 1/2"	No	3	7	—	Broke loose along one side of V. Weld full of laps.	This looked like a good weld, except that it was not through.
25	Torchweld	9	1/4"	1 3/4"	Not in Places	12	13	—	Clean and sound where welded.	Weld not entirely through at bottom of V.
27	Oxweld	10	1/4"	1 1/2"	Not in Places	9	11	—	90% of fracture sound, rest not welded, many small laps.	Top 1/8" of weld badly lapped. Bottom of V for length of 1" not welded.
28	Oxweld	7	1/4"	1"	Yes	—	31 N. B.	1	Clean and sound.	
29	Prest-O-Lite	6H	3/16" High Carbon Steel	1 1/4"	No	1	2	—	Top 1/8" of weld porous and dark. Many small laps.	High carbon steel welding wire. Piece did not bend.
30	Davis-Bournonville	7	3/16"	1 3/4"	Yes	—	30 N. B.	1	Clean and sound.	No cracks when bent.
44	Oxweld	8	3/16"	1 5/8"	No	10	12	—	Upper half dirty and porous.	Neither side of V welded at bottom.
45	Davis-Bournonville	7	3/16"	1 3/4"	No	15	27	—	40% of area not welded one side of V broke loose first, where not welded.	To the eye this was a good looking weld.
46	Oxweld	8	3/16"	1 1/8"	No	2	6	—	Broke loose along one side of V. About 50% welded fairly.	Top of weld full of small cracks. Piece did not bend.
47	Neagley	2	1/4"	1"	No	—	—	—	Not welded at all on either side of V. Added material full of laps.	4 taps on floor broke one side of V, and 6 light hammer blows the other. Tip altogether too small. Piece did not bend.
48	Davis-Bournonville	7	1/4" Vanadium Steel?	1 5/8"	Yes	—	18	—	Clean and sound. Except 2 laps 1/8" long.	At 18 blows broke short off, and numerous small cracks showed on top of weld. Possibly vanadium steel wire used.
57	Davis-Bournonville	4	1/16"	1"	No	2	5	—	Broke loose along one V. Weld almost entirely laps.	Tip too small. Piece did not bend.
59	Vulcan	8	3/16"	1 5/8"	Not in Places	4	8	—	Top of weld full of laps. Broke loose both sides of V at top.	Bottom of weld better than top.

Numbers at left of Table refer to Test pieces. The engineer in charge of tests had no knowledge of operators submitting test pieces, kind of torch used, etc. Suggestions of a helpful nature, in connection with this test, are to be had on application to the Editor, but because of tests to come, cannot be published.

because of the treatment which the wire has received during the manufacture. In number 29, this has not extended as far as in the case of number 25. Really, the condition of the carbide of iron, or cementite, in the wire, has no bearing on its condition in the weld; that is, its physical condition, the latter being always the same regardless of the condition in the wire. In other words, a thoroughly annealed wire would give the same results in the weld as one that was hard drawn, or as a piece of cast steel of the same chemical composition. It is a mistake to state that the quality of the wire, aside from its chemical composition, has anything to do with the quality of the weld.

The curious thing about weld number 29 is that it contains a



much larger amount of carbon than the wire which was sent with it. This weld has probably .7 per cent. carbon in it, and could not be made, under proper conditions, with welding wire containing less than .9 per cent. carbon. The statement in the "Remarks" column of the table as to the carbon content of the wire was based on an examination of the weld. At that time, the wire had not been examined.

As we see it, there are only two explanations of the facts:

First: That a piece of drill rod, or similar high carbon steel, was used in making the weld; the sample being wrongly selected.

Second: An excess acetylene flame was used during the welding. This last would appear almost impossible, but we know of one case where this was done, the results of the welding being entirely unsatisfactory, and causing much trouble; so it would not be surprising if this were the explanation.

Number 48 shows about .15 per cent. carbon, and the statement that it is possibly vanadium steel is based on the outside appearance of it, although we may be in error as to the vanadium.

The microphotographs of some of the welds are quite interesting. It will be noticed that some of the welds, of which the fractures look good, are in reality quite unsound, and the necessity of the microscopic examination appears to be made evident. The laps found in some of these welds are, of course, invisible to the eye, but they are just as dangerous as if they could be seen clearly. In a way, they are worse than visible defects, because the welder believes that he has made a good job when he has not.

It is a question whether much should be said, at the present time, as to the proper method of making a good weld, because it would give those who get their pieces later what seems to be an unfair advantage over the earlier welds. However, it would be perfectly fair to suggest to those, whose welds were imperfect, that they follow the method of breaking a number of pieces after they have welded them, until they arrive at a point where they are reasonably sure of making a good weld.

Number 6 is typical of low carbon steel wire such as is generally used for welding. The specimen was etched for grain size, and the grain boundaries can be seen as faint dark lines. The carbon exists, in wire of this nature, which contains not over .10 per cent as small particles of cementite.

Number 25 shows a considerable amount of pearlite, indicating that the carbon content is about .25 per cent.

Number 29 shows sufficient pearlite to indicate a high carbon content, probably about .4 per cent while number 48 shows about .15 per cent. This last also shows some small particles of cementite, which occur at times in material of this low carbon.

It will be noticed that, in numbers 6 and 48, which were both etched for grain size, the particles of cementite and pearlite lie along the grain boundaries. Numbers 25 and 29 were not etched deeply enough to show the grain boundaries, but the pearlite lies at the grain boundaries as it does in the other samples.

A comparison of number 29 wire with the weld will show the very great increase in carbon in the weld, the explanation of which is previously stated.

Cutting Costs

Editor: Please send me the following information:

1—What is the cost of cutting per hour, including oxygen and acetylene?

2—What shall I charge per hour?

3—Could you give me a form of a time card as the time amounted oxygen and acetylene used on a job?

4—What is the cause of my oxygen regulator freezing when I work outside on a cold day?

I am just going into business for myself and the above questions would help me very much. Louis Cohen.

Answer:

1—The cutting cost per hour depends on the make of apparatus you use. If you will write to the manufacturers they will send you a catalog giving this information.

2—This depends entirely on the thickness and conditions of metal to be cut, and the amount of gases consumed.

3—Time card is mailed.

4—This only occurs when the oxygen is taken from cylinder very quickly and consistently, and freezes due to sudden expansion. Editor.

Nickel Steel Bars

Editor: I am doing some welding, but not much. It is repair work and yesterday I got struck on a job. I had some nickel steel bars to be welded and then tested, but they did not stand the test. I welded them as I would steel. First I tried high carbon steel, but that did not hold, and then I tried nickel steel for filler rod, and it did not hold. I had the bars champered to a 45-degree angle and still it did not hold, so I lost out on it. So that is why I am waiting for your book.

M. C. Russ.

Answer: It is absolutely impossible to make any kind of a steel weld hold when welded with a high carbon rod, as the intense heat of the oxy-acetylene flame destroys the structure of rod when brought to the welding point. Editor.

Phosphoretted Copper

Editor: We would appreciate it very much if you would let us know where we can secure phosphoretted copper for welding copper work, or where we could obtain the formula for making up these rods. Manufacturer.

Answer: We do not know where you can secure phosphoretted copper welding rods on a jobbing basis. Some of the larger apparatus companies sell these rods, but we are under the impression they have them manufactured.

We understand that about one-half of one per cent of phosphorus is present in an otherwise pure electrolytic copper rod. Editor.

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War and the Longest Purse

WHEN a battleship is about to go into action, the decks are cleared of everything—even the boats are set adrift. Nothing is left that may get under the feet of the men who are to engage in giving battle to the hostile craft. The great, gray, steel fighting machine, weighing thousands of tons, must not be handicapped by any trifling impedimenta. War is grim work.

When a nation plunges into war, the decks should be cleared for action. It is legitimate, in times of peace, to spend money for music and flowers and delicacies, pictures and the theaters, equipages, pleasure cars, vintages, Paris gowns and rare gems. All these contribute in their measure to culture and civilization. But when the Hun is at the gate there is no time for feasting and the sound of pipes. Purple and fine linen and sumptuous fare will not repel the barbarian. It is a question then of naked, unhampered bodies brandishing steel and working the guns, toiling at the forges and shaping the ton-heavy ingot of metal on the lathe. War, again, is grim business.

America has awakened to the realization that there is a powerful and unscrupulous enemy determined to defeat her, throwing every ounce of economic strength into the task. If this enemy is to be defeated, the United States must make war in deadly earnest, and one of the deadliest blows that can be dealt is to provide the Government with all the money it can use in financing the campaign against Prussianism, for, in the end, the army with the longest purse will win.

Germany boasts of her many loans, but Germany has pyramided her loans on a financial foundation that sooner or later will bring the whole structure down with a crash that will be heard around the world. Germany has built her war loans on a gold reserve smaller than that in some of the subtreasuries of the United States. German money today is in about the same unhealthy condition Confederate money was south of the Ohio River in 1863, when Atlanta's letter carriers, receiving $6,000 a year pay, were forced to resign because the $6,000 would not provide enough food to keep them and their families alive.

"Buy United States Liberty bonds and thrift certificates; lend the Government all the money it needs," said a great financier recently, "and force Germany to new loans, that the day may be hastened when her comparatively small gold reserve will no longer be able to support the enormous weight of credit built upon it, and her financial structure will collapse. Our soldiers and sailors are busy with the task of defeating Prussianism in the field; contribute your crushing blow by beating her financial structure into a hopeless pecuniary wreckage.

"If Germany is not beaten financially, as well as in the field, this war will have been fought in vain, for she will, at the close of hostilities, use her banking power to bring about the commercial subjugation of the world that her army power failed to crush.

"He also serves who upholds the hands of the United States Government with his money."

Advertising the Job Shop.

MANY welders do not attach sufficient importance to the business-getting value of photographs of interesting and unusual welding jobs. Such photographs, if used properly by the welder, would bring business into the shop and greatly stimulate the growth of the business. We are hearing a lot these days about the conservation of all kinds of food and material, but we see very little in the newspapers about the money that's laying around in scrap heaps.

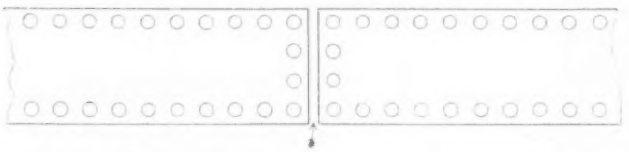
Every job welding shop should be doing something to educate the general public as to the utility of the welding process. To help our friends and readers throughout the United States do this *The Welding Engineer* is going to secure a collection of "before and after" photographs which will be valuable for advertising purposes. After these photographs have been used in *The Welding Engineer* they will be available, under a plan to be announced later, for the use of job shops everywhere.

For the best photograph received before February 5th of an unusual welding job, *The Welding Engineer* will pay $5.00 in cash. It may be a big job, or a little one, but it must illustrate clearly the saving and conservation qualities of some welding system. The photograph must be accompanied by a statement describing method of welding, cost of labor, materials and gases, and also an estimate of the cost of new part, and estimated cost of delay if welding had not been done, etc.

We trust that welders everywhere will help *The Welding Engineer* give a little boost to the whole industry.

PLATE WELDING

Editor: Can you tell me what my trouble is in this case? I work in a shipyard, and in a butt weld of ¼-in. plate I start at bottom and weld up and when it gets cold I find it has a crack in it. Any helpful suggestions you could give I would be thankful for. I use a K & G. Torch with a No. 5 tip for the job. I also



should say that the plate is for the outside base of a cabin about 12 or 15 in. from deck up. A. Whiteman.

Answer: This kind of job certainly should offer no difficulties as to welding; the breaking of weld when cooling is caused by lack of elasticity due to oxidation.

If you will carefully watch your flame and see that you do not carry an excess of oxygen or acetylene, I am sure you will be able to make their weld hold. Editor.

Mails are being delayed. If your copy of The Welding Engineer is late, be patient.

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INSTRUCTION IN CUTTING FOR ELECTRIC WELDERS

Editor: I have read, with much interest and pleasure, the article by Mr. William Herron in your December, 1917, issue. The position he takes, that proper instruction in cutting is necessary for efficiency and economy, is so seldom taken that it is really refreshing to find it so clearly stated.

There is one point on which I believe greater stress should be laid, which is, that the presence of paint, rust, scale (such as is found in boilers), or any other dirt on the surface of the steel, interferes greatly with the smoothness and cleanness of the cut, and increases very much the amount of gases used. So that in cutting such material, a good workman should not be blamed if his performance is not as good as with clean metal. The conclusion is that all possible cleanness of the metal should be obtained by sledging, scraping, or other means, both inside and out, before starting the cut.

There is one small error in regard to the melting point of mild steel, which is given as 2860°F. The latest results of the Bureau of Standards, the tests being made by Doctor Burgess, are 2730°F., for the melting point of pure iron; the melting points of mild steels are less than this, depending on the carbon content. The above figure, 2730°F., is undoubtedly the most accurate result ever obtained.

There is one other point, however, that deserves more serious consideration. If it were only referred to once, it might be passed over as a slip; but when it is mentioned so often, it cannot be so considered. I refer to the statement that the iron oxide is burnt during the cutting. The statement stands in various forms, some of which are as follows:—

"oxide of steel burns";
"the oxide will burn";
"as rapidly as new oxide is found, it is burned";
"forcing the burnt oxide through the metal";
"more oxide is therefore completely consumed."

There is apparently some confusion in thought as to what actually occurs, but if the word "iron," or "metal" were substituted for "oxide," the statements would be correct. The fact is that *oxide* of iron is the *result* of the burning of the *iron* in the steel, by its combination at red heat with the oxygen of the cutting jet. This is the same thing as the burning of wood or coal, by the combination of the carbon in them with the oxygen in the air, resulting in the production of oxides of carbon, carbon monoxide (CO) in the case of incomplete combustion, or carbon dioxide (CO_2) in the case of complete combustion.

In the burning of iron, there are formed also two oxides: ferric oxide, which is the same as ordinary rust, Fe_2O_3, and the magnetic oxide, Fe_3O_4, whose presence can be recognized by a magnet attracting it; hence its name. These oxides cannot be burnt, but are the *result* of burning, as stated above. The result of all burnings that occur to the writer, at present, is the formation of oxides, or combination of oxygen with various materials.

The statements, as they stand in the article, would not mislead those familiar with the subject, but for the benefit of those starting in the work, the writer believes attention should be called to the inaccuracy. S. W. MILLER.

SIMPLE WELDING FIXTURE

Editor:

It has been the writer's experience that in the lighter class of welding work on quantity production, that the technique of controlling the flame and fusing the metal is comparatively simple, especially when welding low carbon or mild steel parts that are not under great load.

However, temporary set up are not time savers in this case, neither is it always wise to invest money in elaborate fixtures. A case of this kind is shown in the accompanying sketch of a welding fixture which cost only $5.00 and has given the best of service.

The Wayne Ford valve grinder, shown in Fig. 1, is composed of an arm of 5/16-in. cold rolled steel welded as noted to a stem of 5/16-in. cold rolled steel. The handle, pin plate and knob are assembled on the unit of stem and arm.

It is evident that there can be no great load on these parts because of the use to which the article is put. However, we might remark that the welded section is fully as strong as the

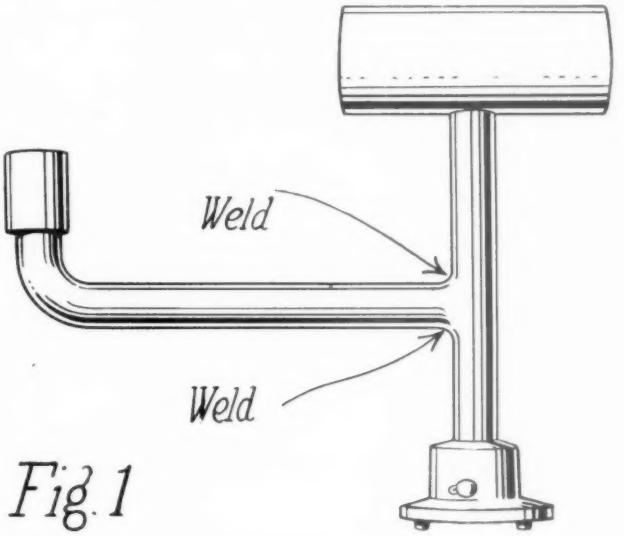
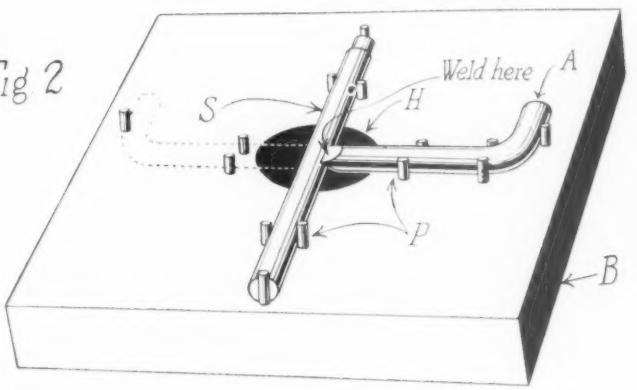


Fig. 1

5/16-in. section under tension, torsion, and cross bending. Altogether it is an ideal method of construction.

Having made a few of these with set ups by eye it became evident that a fixture was necessary. So a cast iron plate (B), as shown in Fig. 2, was made and a hole (H) bored out near the center to receive a refractory material, necessary to prevent conduction and sticking of parts to plate. Holes were drilled in the proper places in the plate and pins (P) of drill rod driven in so as to receive the arm (A) and stem (S) in their

Fig 2



proper relaton. As shown by the solid lines the arm (A) is beveled from both sides and the weld is first made with the parts in position, as shown, and then turned over into position, as shown by dotted lines, and the second part of the weld made while the first is hot.

The production on this fixture is one complete assembly every two minutes.

The work is done with a Prest-O-Lite Type H welding plant, using a No. 4 T. Gas consumption (acetylene), 14 cu. ft. per hour; oxygen, 15 cu. ft. per hour.—W. Burr Bennett.

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MR. KOPFERSCHMIDT, Master Welder of the Michigan Central Railroad, and a regular contributor to The Welding Engineer, says:

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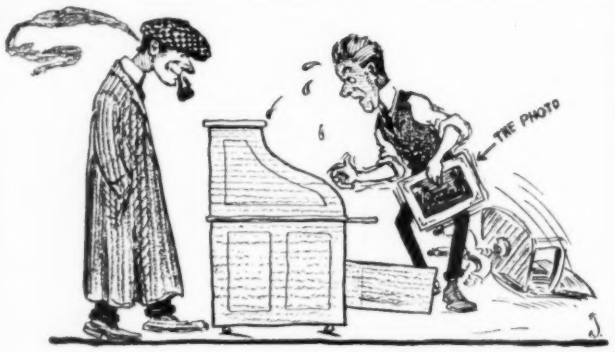

Hold on! What were you doing just then? Storing away that interesting bit of welding experience, or a photograph, perhaps? Don't do it? Give it to us. We want to show it to 4,099 other readers of The Welding Engineer (you're the forty-one hundredth). If there are objectionable features to it, just leave it to the Editor (he studied surgery), cutting off and adding to is his hobby.

Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

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HYDROGEN

Editor: Will you please give me some information on the use of hydrogen in welding and cutting. Is it better than acetylene, and if so in what way? What precautions, if any in handling? What is the cost for both cutting and welding as compared to acetylene?

Are special torches required? Who are the makers, and in your opinion which is the best?

Are there any books of instruction dealing exclusively in the use of oxy-hydrogen for welding and cutting?

H. S. Nix.

Answer: There has been a great deal of discussion relating to the use of hydrogen for welding and cutting, and there are many opinions on this subject. *The Welding Engineer* never makes comparisons between systems, as we confine our activities in this direction to technical opinions of various authorities.

I know of no book published exclusively on the subject of oxy-hydrogen, but it is possible that some companies issue bulletins on the subjects. List of manufacturers has been mailed to you. Editor.

SAVING FROM SCRAP HEAP.

In an address on "How the Railroads Save From the Scrap Heap," delivered before the New York Railroad Club, M. K. Barnum, Baltimore & Ohio Railroad Co., said, in part:

"One of the biggest savings that have been effected is by the welding of broken cylinders. One of our master mechanics told me recently that a saving of about $4,000 had been made in one month by the welding of broken cylinders. The welding of firebox sheets, both for repairs and new work, is being successfully done, and in some railroad shops the entire firebox is welded up without the use of any rivets except in the mudring.

"A good deal of track material is sent in as scrap which in the past has been thought not worth working over, but we have found that it pays to reclaim track spikes, nuts, washers, track bolts and anti-creepers, and much can be saved by building up worn switch points and frogs by the welding process."

NEW CUTTING MACHINE.

A new steel cutting machine, the Gas-O-Plane, is soon to be offered for use in the steel shipbuilding plants and allied industries. The Gas-O-Plane is a machine designed to replace the use of the steel tool planer, a machine which faces the butts and ends of steel plates used in the fabrication of steel ships.

The Gas-O-Plane is an electro-magnetic device carrying on a lathe-like bed an oxy-acetylene or oxy-hydrogen cutting torch. The machine is portable, weighing about thirty-five pounds, and cuts a length of four feet on any thickness material at one setting. The utmost precision and quality in cutting is brought about by the use of this machine, the outstanding feature being that the machine is free from vibration, the essential requirement necessary for a smooth surfaced cut. The function of the electric magnets being to secure the device to the steel surface.

The Gas-O-Plane has been designed especially for accurate straight-line cutting. The Circ-O-Plane, a machine based upon the same principle with an angular cutting torch, has been designed especially for precision circular cutting. Pipe flanges and other circular work can be cut from steel plates by this new machine that will require absolutely no machining, the surface of the cut being as smooth as no steel tool could compete with.

Mr. William Herron of New York, the prominent welding and cutting expert, and author of many interesting articles on torch practice in *The Welding Engineer*, is the applicant for patent rights.

J. E. Erickson, owner of a model machine and welding shop at Worthington, Minn., has issued an attractive calendar, which consists of an interior view of his establishment.

Mr. L. Campbell, of the United States Welding Co., Minneapolis, has been commissioned a first lieutenant in the Ordnance Corps.

NEW INSTRUCTION BOOK.

A new book of instructions for welders has been issued by the General Welding & Equipment Co., 107 Massachusetts Ave., Boston, Mass.

WELD FROM BOTTOM UP.

Editor: I read *The Welding Engineer* from cover to cover each month and there is one subject I have never found debated, and that is, which is better in welding a vertical seam, from the top down, or from the bottom up? I can do better work myself by welding from the top down, yet others contend that from the bottom up makes the better weld. Theoretically, which would you consider the better?

C. H. S.

Answer: It is always best to weld from the bottom up, as that serves two purposes: it preheats plate ahead of weld, therefore increasing speed, and also gives welder a foundation to build on. In welding from top down you lose these two essentials and also cut down the speed of welding. Editor.

Classified Ads

Help Wanted—25c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—50c per line, minimum 4 lines.
Count 8 words to line. Add 6 words for keyed address.

Wanted—Salesman to solicit subscriptions to *The Welding Engineer*, or furnish names of possible readers. Compensation good. Correspondence confidential. Write Mackenzie.

Wanted:—Hustler who wants interest in welding business and who can be adaptable to all repair conditions in shop and handle welders efficiently. Give experience in detail. C. B. Gale, 241 W. 64th St., New York, N. Y. Jan.—1t.

Wanted:—Two large Prest-O-Lite, Commercial or Searchlight welding cylinders. State style and lowest cash price. Wilkes Barre Welding Co., Wilkes Barre, Pa. 1—2

Wanted:—One cast iron face plate for use in oxy-acetylene welding work, approximately 3 ft. by 6 ft. Address Faceplate, care *The Welding Engineer*. Jan.

WANTED:—Two No. 1 welders. Steady work (9 hrs.) No labor trouble. Men must thoroughly understand their business. Superintendent in charge, oldest welder in country; hit or miss operators won't do. Rapid advancement. Address Box 27, care *The Welding Engineer*. Jan.

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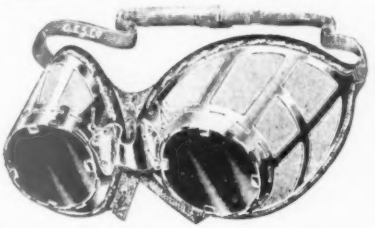

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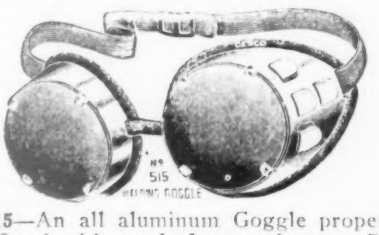

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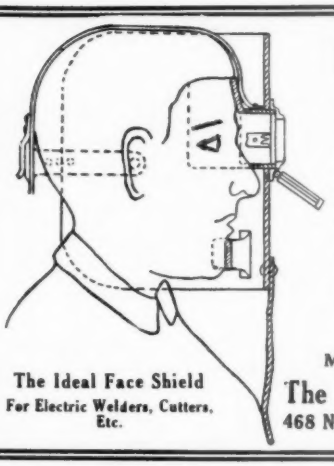

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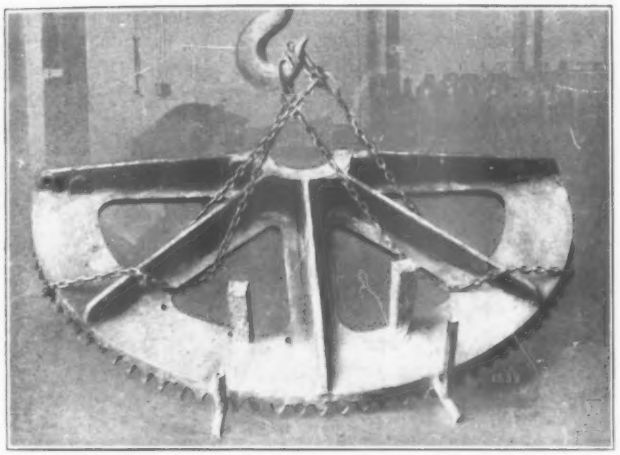
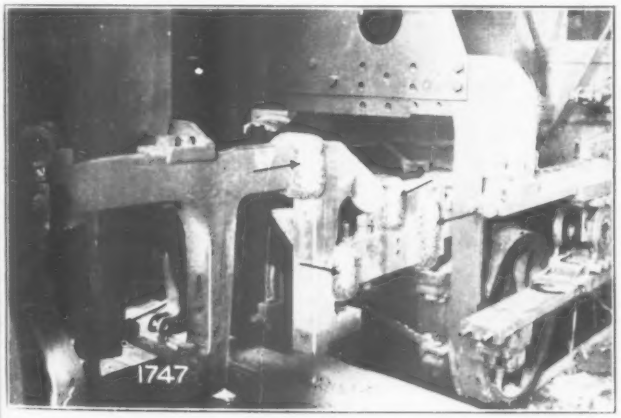
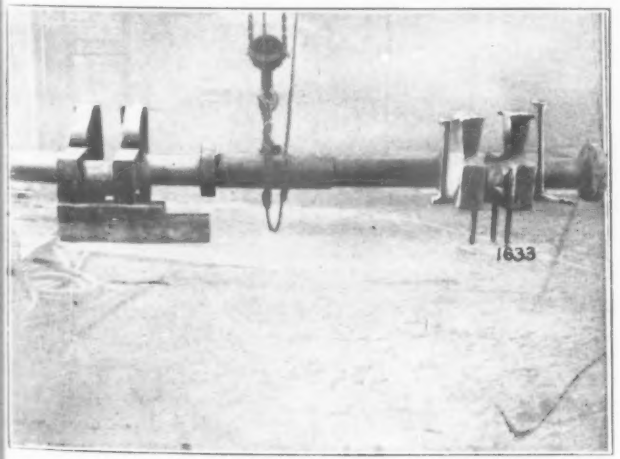


Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



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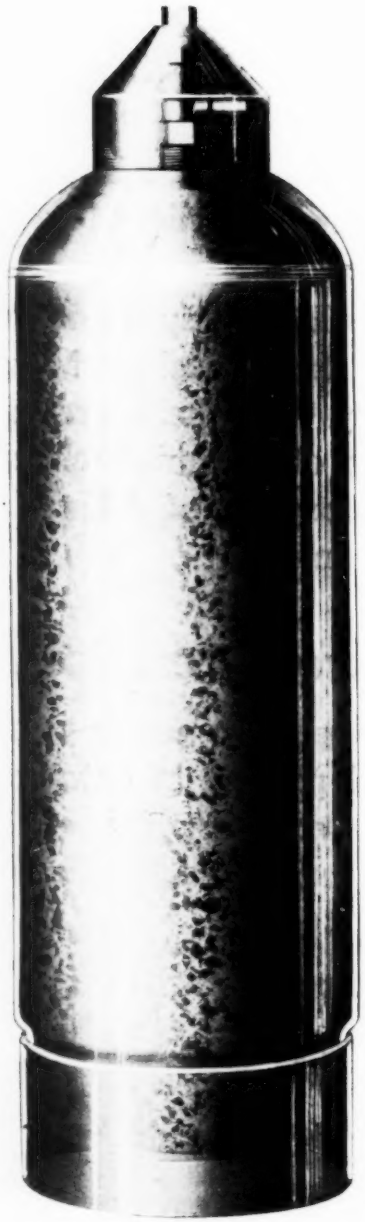

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When the drawing or cupping process has been completed the open end of shell is trimmed off to the required dimensions and the bottom of shell then pressed as shown above so that foot ring or stand can be applied.

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